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TABLE OF CONTENTS.

LEADING ARTICLES:	Page.
Collapse of the Chamber of Commerce Bldg., Cincinnati, O. (illustrated); Cliff M. Stegner	121
Asphaltic Oils for the Preservation of Railway Ties; Frank W. Cherrington	122
Pile and Slab Trestle of Reinforced-Concrete; Chicago, Indiana & Southern Ry. (illustrated)	123
Determination of Stream Flow During the Frozen Season; C. Robert Adams, Assoc. M. Am. Soc. C. E.	124
Elimination of Railway Grade Crossings in Cleveland, O.; Robert Hoffman, M. Am. Soc. C. E.	126
Road Building in New York State; With Additional Data on Top Courses of 2-in. Cubes of Clay and Concrete (illustrated); W. G. Harger	128
Regulation of the Level of Lake Erie	129
A Derrick with Inclined Mast Supported by a Cruciform Sub-Surface Foundation (illustrated); Eric Swensson	130
The Opportunity for Engineers in Highway Work; A. N. Johnson, M. Am. Soc. C. E.	132
Levee and Drainage Project at East St. Louis, Ill.; T. N. Jacob	132
A Multiple-Spool Hoist for Foundation Work (illustrated)	133
The Presidents of Four National Engineering Societies. (With inset sheet of portraits)	134
A Logical Basis for Valuations of Interurban Street Railways; C. G. Young, Assoc. M. Am. Soc. C. E.	141
The Work on the Raising of the "Maine" (illustrated)	143
Keeping Records of Treated Ties; F. J. Angier	143
Report of the "Joint Board on Metropolitan Improvements" on the Electrification of the Steam Railway Lines Entering Boston	144
The Report of the Board of Army Engineers on the Reclamation Work	146
Annual Convention of the Illinois Society of Engineers and Surveyors	149
The Calumet Drainage Channel and Its Relation to the Sewage Disposal Problem at Chicago; L. K. Sherman, M. Am. Soc. C. E.	150
Annual Meeting of the Canadian Society of Civil Engineers	150
EDITORIAL	137
American and British Standards of Per Capita Water Consumption.	
The Report of the Metropolitan Improvement Board on the Proposed Electrification of Steam Railways Entering Boston	137
A Review of the Work of the U. S. Reclamation Service	138
LETTERS TO THE EDITOR	139
Licensing Engineers; G. K. Hooper, L. H. Gardner—Some Methods of Finding the Width of a Stream (illustrated); Herbert A. Kohnhorst—A Diagram for Determining the Safe Load on Piles (illustrated); Arthur S. Millinowski—The "Distant Point" Method for Locating Soundings (illustrated); James Logan—Gas as Fuel for Cremating Dead Animals and Incinerating Garbage; A. N. Miller—Notes and Queries.	
ENGINEERING NEWS OF THE WEEK	151
PERSONALS	152
ENGINEERING SOCIETIES	152

Collapse of the Chamber of Commerce Bldg., Cincinnati, O.

By CLIFF. M. STEGNER.*

On the evening of Jan. 10, 1910, a small fire in the Chamber of Commerce building of Cincinnati, O., resulted in a collapse of the larger part of the building's interior; seven persons were killed. The destruction of the building was almost unbelievable to those familiar with it, as it was generally considered a fair specimen of fireproof construction. Achilles-like, the building had a vulnerable spot which, penetrated by the darts of flame, soon converted a stately structure into a horrible sepulchre.

The wrecked building was planned by H. H. Richardson, the Boston architect, after a spirited competition in 1886. Mr. Richardson died shortly after the awarding of the competition, and his successors, Shepley, Rutan & Coolidge, completed the work in January, 1889. By many the Chamber of Commerce was considered Cincinnati's most imposing structure. At the time of its erection it was one of the notable buildings of the country.

Located on the southwest corner of Fourth and Vine Streets, in the heart of the business district, it covered an area of 100 by 150 ft. and was about 200 ft. high. The massive granite walls are 6.5 ft. thick at the base and 2.5 ft. at the eaves, supporting a closely laid red tile roof rising 75 ft. in the center, with four conical towers at the four corners. The romanesque dignity of the exterior must be seen to be appreciated.

The ground floor was built for banking purposes. Over it the Exchange hall, 50 ft. high, had a clear and unobstructed area of 66 × 136 ft. in addition to the lobby. Above were three rented floors and a loft, all supported by steel trusses under the roof. The construction was generally steel with hollow tile fireproofing and flat floor arches supported on walls and columns up to the Exchange floor. The three floors above were suspended from unprotected steel trusses, the suspenders consisting of two flat eyebars covered with metal lath and plaster.

The skeleton construction of this building was one of the first in which steel was used. All previous work in this locality had been of wrought-iron. The change from iron to steel for this building represented a saving of about $20,000.

The fire broke out at about 8 p. m., Jan. 10. How it originated is still a matter of conjecture. The top floor of the Chamber of Commerce was used by the Business Men's Club for dining rooms and the club kitchen. Above this kitchen in the loft (which the architect never intended for any use whatever) was the kitchen for the club's help, the ice chest and general storage of junk of all sorts and descriptions accumulated by the Chamber of Commerce and its tenants for twenty years.

It is supposed that vaporized grease deposited in the hood over the range took fire, and either through a defective flue or some other means the fire was communicated to the loft, which was soon a raging furnace. The unprotected roof-trusses became heated, slowly yielded, and within 15 minutes after the alarm was sounded and before a fire stream was put into action the top chord of the south truss buckled, dropping with its burden to the basement and pulling six other trusses from their seats. Seven lives were lost in the catastrophe and a worse mass of tangled ruins is hardly conceivable.

The view Fig. 2, on the next page, shows the buckled top chord and first diagonal of the west

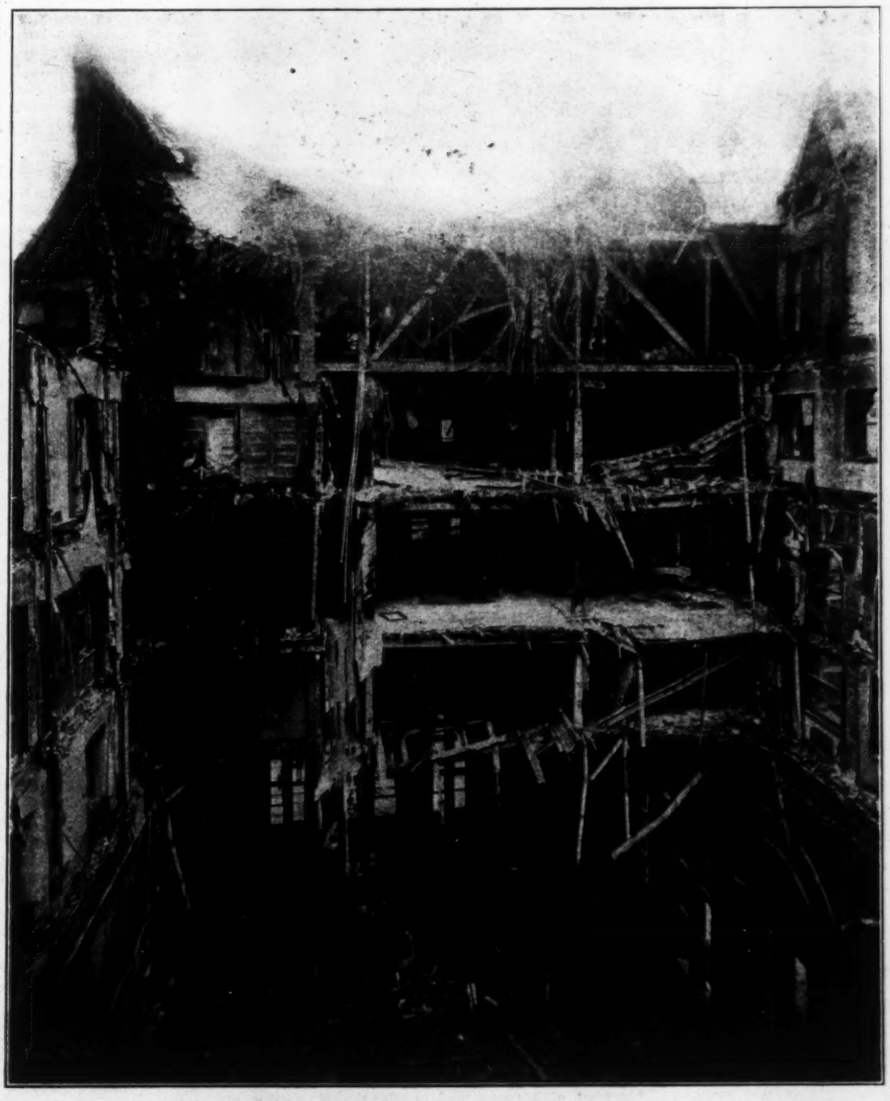

FIG. 1. INTERIOR VIEW OF THE WRECKED CHAMBER OF COMMERCE BLDG., CINCINNATI, O.
(Seven persons killed in the collapse.)

*Engineer Department of Buildings, City Hall, Cincinnati, O.

end in the south truss, which was the first to give way. The remainder of the truss, including the end post which was cut away in the search for the dead, was comparatively straight. All material was otherwise in good condition and well preserved.

Fig. 1 shows the 7 remaining trusses, spanning 70 ft. from wall to wall at intervals of 8 ft. on centers, which supported the roof, loft and three floors.

The end posts, the first diagonal and top chords consist of two 15-in. channels with one 18 × ⅜-in. plate riveted to the top and lattice bars underneath. The bottom chord is composed of two 15-in. channels and the center diagonals of two 8-in. channels. The truss height is 12 ft. 9

FIG. 2. THE ROOF-TRUSS CHORD WHICH BUCKLED IN THE FIRE AND CAUSED THE COLLAPSE.
(End post cut off during search of ruins.)

ins. center to center of pins, and all connections throughout (with the exception of the riveted top connection of center diagonals) are by pins.

The tile roof construction, whose apex was 75 ft. above the truss seats, was carried on an angle framework supported on the top of the trusses. To this framework were secured the 2 × 2-in. angle purlins, spaced about 4½ ins. on centers, to which the roofing tile was tied with copper wire.

A computation of stresses in the steel trusses showed that the sections were ample for the loads they carried, and had they been properly protected the fire in the loft could have been subdued before the collapse with a few thousand dollars loss at the most, instead of a nearly total destruction of a $500,000 building, with the inestimable loss of human life.

The unprotected roof-trusses in this building were not in conformity with the present Cincinnati building code. But the code is not retroactive in regard to its fireproofing provisions, and is applicable to new structures only.

Asphaltic Oils for the Preservation of Railway Ties.*

By FRANK W. CHERRINGTON.†

The results obtained in the treatment of railway ties by asphaltic crude oil, by the Santa Fe Ry. and the Mexican National Ry., have proved that waterproofing asphaltic crude oils have a claim for serious consideration as successful wood preservatives.

An investigation of the asphaltic crude oils located outside of California or Mexico shows that in their natural condition they are too volatile, highly inflammable and not sufficiently viscous to prove of value as a wood preservative. Therefore, it is necessary to refine these oils in order to secure preservative oils which are similar to (and in some instances superior to) the Western asphaltic oils.

The accompanying table gives analyses of two natural asphaltic oils and the refined product of an asphaltic crude oil found in the central United States. All of these oils are obtainable in large quantities and at low cost. The thick analyses indicates what may be accomplished by refining the asphaltic crude oils of the East, and thereby securing an asphaltic residual oil which is practically non-volatile, non-inflammable, and at the same time, not nearly so viscous or hard to handle by the average plant equipment as the California crude product or the Mexican oil.

Creosote is naturally easier to handle in pumps and pipes than the more viscous asphaltic oils. In practice, however, at plants of standard equipment, the pumps and valves were not affected to any appreciable degree by the viscosity of the oil.

During April, 1910, various tests were made at the C., B. & Q. Ry. experimental plant at Galesburg, Ill., to determine whether this refined asphaltic oil could be used as a substitute for creosote oil in the Card process. A mixture of 23% asphaltic oil and 77% of a 5% zinc-chloride solution was used. The results proved that asphaltic oils could not be used in the Card process, because of the formation of a viscous emulsion, or saponification, which permitted the zinc chloride to penetrate the wood in large quantities but prevented the entrance of the asphaltic oil into the wood. Additional test runs were made to determine with what degree of success the straight asphaltic oils could be injected into the wood. Finally a mixture of 75% of asphaltic oil to 25% of creosote was tried. The experiments demonstrated that fairly good penetration could be secured on ties of various oaks, elm, beech, gum, etc., when injecting all the preservative the ties would absorb. This maximum amount was found to be about 7 lbs. per cu. ft. Pine ties (short leaf) were found to readily absorb the straight asphaltic oil in good quantities with thorough penetration.

The treatment with 25% creosote to 75% asphaltic oil showed that the viscosity of the oil was greatly reduced by the addition of creosote. About the same penetration and absorption could be obtained as with straight creosote, but with a greatly reduced cost of treatment.

From analyses made it is safe to state that the mixture found in the treated ties approached the original proportions, and that the mixture injected into the ties contained about the same proportion as the original mixture before injection.

In 1909, a tank car of the heavy asphaltic residual oil was sent to the low-pressure plant of the Indianapolis, Columbus & Southern Traction Co., at Columbus, Ind. This initial test proved a failure because of the inability of the small capacity pressure pump at the plant to handle the thick, viscous asphaltic residual oil, which was at that time much heavier than the product eventually adopted.

Before this test was completed, however, it was found that the asphaltic oil resisted the forcing of zinc-chloride solution through an injection of 3 lbs. of asphaltic oil per cu. ft. to a very much greater degree than the same quantity of creosote. This proved the superior waterproofing quality of the asphaltic oil.

Another test showed the waterproofing quality. A paving block was treated with residual asphaltic oil to the amount of 16 lbs. per cu. ft. It was then dried in an oven at 120° F. for 24 hours, weighed and then immersed in clear water for a period of 24 hours. The gain in weight was found to be 0.02%. The same block, if treated with 20 lbs. per cu. ft. of creosote, would have been allowed to absorb as high as 3 or 4% of the water, by weight.

In November, 1910, a test was made at the Mount Union plant of the Pennsylvania R. R. Three charges were run with straight asphaltic oil, and three with a mixture of 33.3% creosote to 66.7% asphaltic oil. When this proportion of asphaltic oil and creosote was exhausted more creosote oil was added as required until the proportion again assumed 100% creosote.

Sections sawed out of the center of the pine ties showed complete penetration through the sap wood to the heart, this being an equivalent penetration to that secured by the use of creosote. Red oak, beech, elm and gum ties varied in the penetration secured, being dependent upon the amount of sap and heart wood in each tie. The penetration was not equivalent to that secured by creosote in all cases, but approached very nearly the results secured through the use of creosote. When the difference in viscosity between the two oils is considered, this result is not remarkable.

In each of the straight asphaltic runs, eight ties were marked and weighed before treatment, as average samples from the 500 ties composing each charge. After treatment, these ties were again weighed. The absorption per tie in the various woods was not excessive, at the same time giving good penetration in almost all cases. As the asphaltic oil was not absorbed in large quantities when the woods were given a maximum treatment, and as it gave a penetration comparing favorably with that secured by the use of creosote, asphaltic residual oil may be considered an economical substitute for creosote.

The results secured on the mixture of creosote and asphaltic oils proved (as far as absorption per tie and the element of time for treatment may be concerned) equivalent to the results secured by the use of straight creosote oil. It must be admitted, however, that the asphaltic oils when used alone require a longer period of time than for injecting an equivalent quantity of creosote.

Tests were then made with the Rueping process in the treatment of mixed oak and pine ties with straight asphaltic oil. The absorption was very satisfactory, as the same penetration was secured by a limited quantity of oil as was secured by a larger quantity of oil in the straight asphaltic oil pressure process. This experimental test merely showed the applicability of asphaltic oils for use in this process.

It is readily admitted that the only value of asphaltic oil, obtained from the central United States, as a wood preservative, would be in using a parallel treatment to that in which the Santa Fe Ry. has obtained such excellent results, namely, the injection of maximum quantity of oil into the wood.

As the distillation data in the table demonstrate that the fractions of asphaltic residual oil possess high boiling points, comparing in this respect very favorably with good coal-tar creosote and at the same time comparing favorably with the analysis of the Bakersfield oil, it

*Abstract of a paper read at the annual meeting of the Wood Preservers' Association, Chicago, Jan. 17, 19.

†Indian Refining Co. (Wood Preserving Department), Cincinnati, Ohio.

seems reasonable to assume that it has great value as a wood preservative.

It has been claimed that if the asphaltic oils were injected in maximum quantities into the various species of wood, oak, beech, elm, gum, etc., the quantity absorbed by the tie would be so great that there could be no economy in its use. Tests prove that this is not the case. Good penetration has been secured by not over 8 lbs. per cu. ft., which also proved to be the average amount the various timbers would absorb. Thus the amount of oil necessary to secure a maximum injection was not found to be prohibitive from the standpoint of economy.

ANALYSES OF MEXICAN AND CALIFORNIAN NATURAL ASPHALTIC CRUDE OILS AND A REFINED ASPHALTIC OIL.

Locality ..... Name of oil.....	Mexico. Ebano.	California. Bakersfield.	Central U. S. Timber-asphalt.
Flashes in closed tester at °F.....	176	256	410
Flashes in open tester at °F.....	190	268	470
Deg. Beaume at 60° F.	12.1	11.9	19.2
Specific gravity at 60° F.	.9849	.9867	.9388
Distilling Tests, using a retort.	(Percent coming over.)		
0° C. to 100° C.....	...	...	...
100° C. to 150° C.....	1.0	...	...
150° C. to 300° C.....	20.1	15.0	...
Distilling Tests, using flash thermometer opposite takeoff.			
0° C. to 100° C.....	...	...	...
100° C. to 150° C.....	1.1	...	...
150° C. to 300° C.....	22.6	16.0	23.5
Evaporation Tests, placed in open dishes in air oven at 140° F. Oil, 1.4 ins. deep.			
In 24 hours, per cent..	6.8	2.3	...
In 96 hours, per cent..	9.4	4.6	...
Evaporation Tests, placed in open dishes in air oven at 200° F. Oil, 1 in. deep.			
In 24 hours, per cent..	9.8	4.8	.033
In 96 hours, per cent..	11.4	11.5	.132

Pile and Slab Trestle of Reinforced-Concrete; Chicago, Indiana & Southern Ry.

In the construction of the Chicago, Indiana & Southern Ry., the Kankakee Division was carried over the Kankakee River near Shelby, Ind., by a timber pile trestle of ordinary construction. Early in 1910 it was decided to replace this with a more permanent structure, and designs for a reinforced-concrete pile and slab structure were adopted at the suggestion of Mr. W. M. Hughes, M. Am. Soc. C. E., Consulting Engineer, of Chicago. Estimates showed that this could be built complete at about the cost of the superstructure of a plate-girder bridge having 60-ft. spans. The trestle carries a single track, and its total cost was about $46,000. Fig. 1 is a view of a portion of the completed structure.

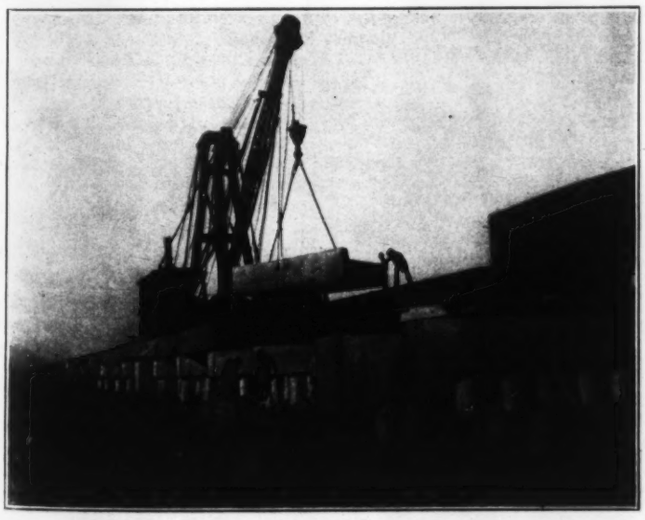

FIG. 2. PLACING THE FLOOR-SLAB SPANS OF THE REINFORCED-CONCRETE TRESTLE.

The old trestle was 1,233 ft. long. The new trestle reduces the length to 1,056 ft.; it includes 54 slab spans 18 ft. c. to c. of bents and a 60-ft. plate-girder span over the channel. This steel span is arranged to provide for its being lifted out by a wrecking crane or derrick car to allow the passage of dredge boats.

Test borings showed the material across the entire bottom to consist mostly of fine sand to a depth of 22 to 25 ft. It was decided to use concrete piles of the Chenoweth type* (reinforced with a spiral coil of wire netting in addition to the longitudinal rods). These are 16 ins. diameter and 25 ft. long, giving an average penetration of about 19 ft. The maximum live and dead load, allowing 25% additional to the live load for impact, is about 30 tons per pile. The piles were put down easily to the required depth by the use of a water jet and under the weight of a 3,000-lb. hammer. Very little driving was necessary, except in a few cases.

There are five piles to each bent. Upon the piles are cast reinforced-concrete caps 30 ins. wide, 36 ins. deep and 15 ft. long. The pile heads are embedded about 12 ins. in the caps. There are five piles to each bent. Each fifth bent has a solid pier 4 ft. thick and 15 ft. long, supported by eight concrete piles 14 ins. diameter and 21 ft. long. These piles are loaded to about 22 tons each. It is considered that in future structures the spacing of these piers (90 ft.) may be increased materially without affecting the longitudinal rigidity of the structure.

Each span is formed by two slabs set side by side. The slabs are 17 ft. 11½ ins. long, 7 ft. wide, 29½ ins. thick at the inside edge (or center line of the trestle) and 28 ins. at the inner side of the curb wall which retains the ballast. The 1½-in. slope to the side provides for drainage to holes which are spaced about 6 ft. apart. Each slab contains about 12 cu. yds. of concrete. The concrete is a 1:2:4 mixture, and contains about 1% of reinforcement consisting of 1-in. square corrugated bars spaced 4 ins. apart. Of these rods, 66% are bent near the ends and extend nearly to the top surface of the slab. At about the point of the bend are placed vertical stirrups made of similar bars.

The slabs weigh between 24 and 25 tons each. They were made at a yard about 1¼ miles from the bridge, this being the nearest available and suitable site for the work. They were loaded on flat cars (usually six cars at a time) and hauled onto the old trestle, which was parallel with and close beside the new structure. The slabs were unloaded and set in place by a bridge derrick car of steel construction, as shown in Fig. 2. The A-frame of the derrick was anchored to the adjacent completed concrete span, which afforded ample weight to resist the lateral stresses in swinging the slab. This anchorage may be seen in the cut. The average number of slabs placed per working day was ten, and the maximum number was 14. Each slab is anchored to the cap at one end by 1½-in. dowels; the other end is free and rests on sheets of zinc, bedded up to the proper elevation with cement mortar. The work of making the slabs was commenced May 26, 1910. Pile driving began on July 20, and the placing of slabs on Oct. 21. The entire work was completed on Nov. 14. Complete detail plans were prepared by Mr. Hughes, to whom we are indebted for our information. The work was done by the Ijams Construction Co., of Terre Haute, Ind., on a cost-plus-percentage basis, under the direction of Mr. R. B. Seymour, Chief Engineer of the Chicago, Indiana & Southern Ry.

FIG. 1. REINFORCED-CONCRETE PILE AND SLAB TRESTLE OVER THE KANKAKEE RIVER; CHICAGO, INDIANA & SOUTHERN RY.

*These piles, in connection with structures of a similar type on the Chicago, Burlington & Quincy Ry. were described in our issue of May 20, 1909.

THE MECHANICAL WATER FILTRATION PLANT of Atlanta, Ga., is being enlarged to a total capacity of 21,000,000 gals. This plant is notable in that it still includes a battery of 12 Hyatt filters, built in 1887. These are of the vertical pressure type, with a continued daily capacity of 3,000,000 gals. In 1892 a 4,000,000-gal. New York horizontal-pressure plant, with sectional wash, was installed at another point. This was duplicated later on. In 1895 the Hyatt filters were moved and placed alongside the New York filters, since which time the plant, as a whole, has had a nominal capacity of 11,000,000 gals., but has often been worked at a much higher rate.

The New York Continental Jewell Filtration Co. was awarded a contract in 1910 for 20 additional filter units of the New York type, with a combined capacity of 10,000,000 gals., thus bringing the total filter capacity up to 21,000,000 gals. These filters are operated as mechanical gravity filters under a pressure of from 8 to 15 lbs. The water-supply of Atlanta is pumped from the Chattahoochee River to a 178,000,000-gal. storage reservoir. A new storage reservoir, having a capacity of 250,000,000 gals., is now being constructed. When completed the total storage capacity will be 428,000,000 gals. The water passes from the reservoirs to two 1,500,000-gal. coagulating basins, and thence by gravity to the filters. Contracts for the construction of two additional units of the same capacity as the old ones have been let, and work is now in progress. When completed, these coagulating basins will have an available capacity of 6,000,000 gals.

Besides the Chattahoochee pumping station, there is a second station, which pumps water directly into the distribution system. We are indebted to Mr. W. Z. Smith, General Manager of the Atlanta Water-Works Office, for not only some of the information already given, but also for the following statement regarding the pumping plant:

We have located at the Chattahoochee Pumping Station three pumping engines of the horizontal compound crank-and-flywheel type, constructed by the Holly Mfg. Co., with a maximum capacity of 38,000,000 gals. per day. The average daily pumping from this station is 15,000,000 gals. At our Hemphill No. 2 Pumping Station we have three similar Holly pumping engines, with a maximum capacity of 35,000,000 gals. per day, and one vertical triple-expansion pumping engine, constructed by the Wisconsin Engine Co., having a capacity of 20,000,000 gals. per day, giving a total maximum capacity at this plant of 55,000,000 gals. The average daily pumpage from this station is 13,600,000 gals. The difference in pumpage at the two stations indicates the amount of water lost by seepage, slippage in pumps, evaporation, leakage and washing of filters.

Determination of Stream Flow During the Frozen Season.

By C. ROBERT ADAMS,* Assoc. M. Am. Soc. C. E.

Records of stream flow have, in recent years, come to be regarded as of prime importance in engineering. Not only are these records of use in investigations of water-power possibilities, but they come into use in studies of water-supply for domestic purposes, irrigation, flood prevention, navigation of rivers and drainage of overflowed and swamp lands.

Records of stream flow have been kept by many parties; chief among them being the Water Resources Branch of the U. S. Geological Survey. For a number of years, this Service has been engaged in keeping records of the flow of a large number of streams in all parts of the United States. In consequence of these studies by the Government, and by hydraulic engineers, the methods of estimating stream flow during conditions of open water may safely be said to have become well standardized.

Methods of estimating stream flow during the frozen season, however, have not become standardized, but have remained in a more or less experimental condition. Attention was brought to this subject in Engineering News of May 11, 1905, in an article by Mr. F. H. Tillinghast entitled "Records of Flow at Current-Meter Gaging Stations When the Streams are Subject to Ice." A more elaborate study of the subject was made subsequently by engineers of the U. S. Geological Survey in Water Supply Paper No. 187, published in 1907, under the same title as the present article. This water-supply paper presented results of numerous experiments but made no conclusive recommendations for a standard procedure. One of the principal results, however, was to establish conclusively the standard method of making current meter measurements under ice cover by the so-called "two-tenths and eight-tenths" method.

Since the publication of the above-named water-supply paper many experimental data have become available which render it possible to arrive at more conclusive deductions than were previously possible. Through the use of these additional data, personal contact with winter work, and a theoretical study of certain features of river flow, the author has arrived at certain conclusions which may be valuable to engineers engaged in this study, and which may lead to the determination of some one best procedure.

Importance of Winter Records of Stream Flow.

The importance of winter records of stream flow is very great. In the Northern States droughts are apt to occur in the late summer or fall and during the winter. At times this condition of drought may be nearly or quite continuous between these two periods, with its culmination in January or February. If there is no melting of snow during the winter the inflow to streams that freeze is chiefly derived from springs, ground water and lake storage, and in a long cold winter, especially if it succeeds a period of low water, the minimum flow for the year may be reached and continued for some time.

Moreover, in winter the measurement of precipitation is more difficult, and available data of this kind are much less accurate than in summer. There is also not even an approximate relation between the snowfall and the stream flow, so that the failure to obtain winter records of flow means a considerable percentage of uncertainty as to the total run-off as well as to its distribution. Estimates of flow, therefore, to be of conclusive value must embrace these winter periods.

Estimates of Stream Flow During Open Season.

It may be well at the outset to review briefly the best practice of estimating stream flow during the open season.

This practice contemplates the determination of the daily discharge at certain places upon streams, denoted as river stations. These stations are ordinarily of two types: (1) where there is regulated flow, and (2) the more frequent and superior type where flow is natural. Stations of the first sort are at dams where water-power is developed. Here the stream flow is divided between water consumption of the turbines and flow over spillways and through wasteways. The daily discharge is computed from ratings of each of these. To compute discharge through turbines it is necessary to use tables compiled to be used with "head on wheels," "wheel-gate openings" and "time of operation" as arguments. These tables are often obtained from manufacturers, but should be used with caution, since with old wheels, or where there is more or less leakage, they are not accurate. In such cases, in order to obtain precise and accurate results, it is necessary to rate the turbines by a series of weir or current-meter measurements. The discharge through wasteways and over spillways is figured from similar rating tables. Satisfactory results demand careful ratings in all individual cases. Where types and dimensions of wasteways and spillways follow exactly those of previously rated wasteways and spillways it is possible to use these prior ratings; but when there is even small deviation it is dangerous practice to apply empirical formulas of discharge over weirs and through orifices that are of different design.

The second type of river station, and by far the more frequent, is that where the stream is flowing in a natural channel and unaffected in water-surface elevation by artificial features down stream. These stations are selected at places where the following theorem will hold true, during open water season, "For a given elevation of water surface at a gage a certain definite quantity of water is passing." Stations of this kind are usually obtainable upon any stream; the primary consideration being to have

TABLE I.—WINTER RECORDS OF STREAM MEASUREMENTS FOR THE CONNECTICUT RIVER, ESOPUS CREEK, FISH RIVER AND KENNEBEC RIVER.

Date.	Width, ft.	Area under ice, sq. ft.	Mean velocity, ft.	Discharge, sec.-ft.	Gage height, ft.				Gage height to water surface.		Gage height to bottom of ice.	
					To water surface.	To bottom of ice.	Thickness of ice, ft.	Snow on ice, ft.	Discharge for open-water conditions, sec.-ft.	Coefficient for reducing open-water to ice conditions.	Discharge for open-water conditions, sec.-ft.	Coefficient for reducing open-water to ice conditions.
CONNECTICUT RIVER AT ORFORD, N. H.												
1903.												
Jan. 24	276	1,760	1.69	2,970	7.33	6.00	...	...	4,925	0.60	3,470	0.86
29	273	1,610	1.63	2,620	6.71	5.40	...	...	4,240	.62	2,880	.91
29	273	1,620	1.66	2,690	6.75	5.50	...	...	4,285	.63	2,975	.90
30	276	1,760	1.69	2,980	7.30	6.00	...	...	4,890	.61	3,470	.86
Feb 7	278	1,810	1.65	2,990	7.38	6.05	...	...	4,980	.60	3,520	.85
7	278	1,810	1.67	3,030	7.40	6.05	...	...	5,000	.61	3,520	.86
1904.												
Feb 3	240	851	1.00	850	4.20	2.40	2.03	...	1,880	.45	815	1.04
3	241	847	.99	840	4.17	2.37	2.03	...	1,860	.45	801	1.05
4	239	804	.93	750	4.03	2.23	2.03	...	1,760	.43	738	1.02
4	236	804	.95	760	3.99	2.19	2.03	...	1,735	.44	720	1.05
5	235	813	.93	760	4.03	2.23	2.03	...	1,760	.43	738	1.03
5	235	805	.95	765	4.03	2.23	2.03	...	1,760	.43	738	1.04
1905.												
Feb. 28	235	775	.88	686	4.07	2.30	2.01	0.1	1,790	.38	770	.89
Mar. 1	235	794	.96	766	4.26	2.40	2.09	.1	1,925	.40	815	.94
1	235	794	.93	739	4.25	2.39	2.09	.1	1,918	.39	810	.91
1906.												
Feb. 8	327	1,920	1.17	2,250	6.84	5.51	1.48	.2	4,380	.51	2,980	.76
15	327	1,870	1.20	2,240	6.80	5.32	1.48	.9	4,340	.52	2,810	.80
17	327	1,790	1.14	2,040	6.56	5.06	1.52	.9	4,080	.50	2,570	.79
Mar. 14	327	1,560	1.08	1,680	6.00	4.56	1.55	.1	3,470	.48	2,160	.78
15	327	1,440	1.04	1,490	5.59	4.15	1.55	.1	3,060	.49	1,840	.81
1907.												
Feb. 20	288	1,080	...	1,100	4.51	3.18	1.72	...	2,120	.52	1,210	.91
21	288	1,050	...	1,090	4.64	3.33	1.64	...	2,220	.49	1,300	.84
1908.												
Mar. 4	345	2,040	...	2,340	7.11	5.91	1.3	...	4,680	.50	3,380	.69
Dec. 24	254	993	...	698	3.53	2.93	0.7	...	1,420	.49	1,060	.66
ESOPUS CREEK AT KINGSTON, N. Y.												
1901.												
Dec. 4	86	280	0.84	236	5.28	5.20	0.083	...	329	0.72	309	0.76
1902.												
Jan. 9	100	419	1.25	522	6.54	6.41	.13	...	716	.73	669	.78
Feb. 28	116	706	2.39	1,690	9.14	8.94	.20	...	2,030	.83	1,900	.89
Dec. 11	90	404	1.18	476	6.60	6.50	.10	...	741	.64	700	.68
11	116.6	1,170	2.96	3,460	13	...	...	...	5,300	.65	...	...
1903.												
Jan. 14	101.6	413	1.03	425	6.9	6.32	.58	...	864	.49	638	.67
Feb. 24	104.6	443	1.47	654	7.1	6.70	.40	...	950	.69	782	.84
1906.												
Feb. 15	90	287	.87	250	5.60	5.17	.33	...	412	.61	302	.83
1907.												
Feb. 18	95	282	...	200	5.68	5.03	0.65	...	435	.46	268	.75
19	93	258	...	179	5.45	4.96	0.65	...	370	.48	252	.71
FISH RIVER AT WALLAGRASS, ME.												
1906.												
Feb. 15	95	205	0.95	195	3.91	2.66	1.25	0.65	620	0.32	225	0.87
15	95	205	.96	196	3.91	2.66	1.25	.65	620	.32	225	.87
Mar. 15	115	312	1.21	378	4.99	3.83	1.20	.9	1,080	.35	380	.65
15	115	319	1.22	390	5.08	3.92	1.20	.9	1,125	.35	650	.63
1907.												
Feb. 13	110	253	...	236	4.40	3.55	1.35	...	803	0.29	479	0.49
13	110	244	...	234	4.40	3.55	1.35	...	803	0.29	479	0.49
Mar. 28	110	253	...	227	4.62	2.92	1.7	...	897	0.25	285	0.80
28	110	246	...	225	4.62	2.92	1.7	...	897	0.25	285	0.79
1908.												
Feb. 18	140	386	...	486	6.45	5.25	1.3	...	1,850	0.26	1,190	0.41
KENNEBEC RIVER AT NORTH ANSON, ME.												
1904.												
Jan. 27	240	393	1.90	749	3.40	1.55	1.8	2.0	3,170	0.24	±675	±1.11
28	240	398	1.97	786	3.40	1.55	1.8	2.0	3,170	.25	±675	±1.16
Mar. 2	230	285	1.86	529	3.55	1.45	2.1	...	3,450	.15	±600	±.88
4	230	285	2.01	572	3.65	1.55	2.1	...	3,650	.16	±675	±.85
1905.												
Feb. 9	458	1,390	1.50	2,080	5.27	3.27	2.10	1.0	7,530	.28	2,920	.71
9	458	1,390	1.54	2,140	5.32	3.32	2.10	1.0	7,680	.28	3,020	.71
1906.												
Jan. 9	440	1,100	1.17	1,290	3.58	2.38	1.28	.1	3,520	.37	1,550	.83
10	440	1,030	1.09	1,120	3.40	2.22	1.30	.1	3,170	.35	1,370	.82
Mar. 2	445	1,140	1.40	1,590	4.26	2.43	1.97	.1	4,980	.32	1,630	.98
3	445	1,050	1.31	1,380	4.08	2.27	1.98	.1	4,580	.30	1,420	.97
30	447	1,180	1.36	1,600	4.77	2.67	2.26	.0	6,220	.26	1,950	.82
30	447	1,200	1.38	1,660	4.80	2.70	2.26	.0	6,300	.26	1,990	.83
Apr. 11	450	1,210	1.37	1,660	4.70	2.80	1.95	±1.0	6,050	.28	2,140	.79
11	450	1,240	1.38	1,710	4.70	2.80	1.95	±1.0	6,050	.28	2,140	.80

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TABLE II.—COMPARISON OF COEFFICIENTS C AND C'.

River and station.	No. of years.	Range in C.	Diff.	Aver. C.	Range in C'.	Diff.	Aver. C'.
Aroostook, Ft. Fairfield, Me.	1	0.34 to 0.43	0.09	0.38	0.74 to 0.79	0.05	0.76
Catskill, South Cairo, N. Y.	3	0.92 to 1.11	0.19	1.00	1.67 to 3.65	1.98	2.70
Connecticut, Orford, N. H.	6	0.38 to 0.63	0.25	0.50	0.66 to 1.05	0.39	0.88
Esopus, Kingston, N. Y.	5	0.46 to 0.83	0.37	0.63	0.67 to 0.89	0.22	0.77
Fish, Wallagrass, Me.	3	0.25 to 0.35	0.10	0.30	0.41 to 0.87	0.46	0.67
Hoosic, Buskirk, N. Y.	2	0.24 to 0.37	0.13	0.30	0.56 to 1.10	0.54	0.83
Hudson, North Creek, N. Y.	1	0.32 to 0.83	0.51	....	.... to	....	....
Kennebec, Bingham, Me.	2	0.15 to 0.35	0.20	0.23	0.25 to 1.16	0.91	0.84
Kennebec, North Anson, Me.	3	0.15 to 0.37	0.22	0.27	0.71 to 1.16	0.45	0.88
Kennebec, The Forks, Me.	2	0.27 to 0.31	0.04	0.29	0.53 to 1.36	0.83	1.11
Mattawamkeag, Mattawamkeag, Me	2	0.16 to 0.35	0.19	0.24	0.42 to 0.87	0.45	0.65
Raquette, Messina, N. Y.	3	0.25 to 0.68	0.43	0.51	0.71 to 1.05	0.34	0.83
Rondout, Rosendale, N. Y.	3	0.15 to 0.78	0.63	0.41	0.40 to 1.71	1.31	1.08
Sacandaga, Northville, N. Y.	2	0.12 to 0.35	0.23	0.24	0.12 to 0.63	0.51	0.41
Wallkill, Newpaltz, N. Y.	3	0.39 to 0.79	0.40	0.56	0.73 to 1.20	0.47	0.89
Winooski, Richmond, Vt.	2	0.14 to 0.35	0.21	....	.... to	....	....
Chippewa, Eau Claire, Wis.	2	0.78 to 0.82	0.04	....	.... to	....	....
Menominee, Koss, Mich.	1	0.47 to 0.71	0.24	....	.... to	....	....
Oconto, Gillette, Wis.	2	0.30 to 0.35	0.05	....	.... to	....	....
Wolf, Keshena, Wis.	2	0.29 to 0.69	0.40	....	.... to	....	....

them so located that fluctuations of water surface at any dam down stream, or from any temporary obstruction will not extend to the gage. This condition is best realized when there is a well defined rapid or fall down stream from the gage. Estimates at such a station are based upon a rating diagram or table, determined from measurements of discharge taken at various gage heights. Average daily gage heights are obtained at the gage, and from them the daily discharges are taken from the rating.

Open-Water Methods Not Applicable in Winter.

Neither of the above methods are applicable during the frozen season, without some revision. On the whole, experience in the past has been that the dam stations have given greater satisfaction at this season.

Ratings of turbines are not affected, while ratings of wasteways and spillways are changed, unless they are kept clear of ice obstruction. This is possible in many cases, for it does not matter how much ice forms in the pond if the few feet at the approach to the spillways are clear, and the nappe unaffected by ice on the crest. Where it is impossible to keep spillways and wasteways clear of ice obstruction it is necessary to rerate them with all considerable changes in ice conditions.

At the stations of the simple gage type, the frozen season has, in the past, almost always been accompanied by uncertainty in the records. It has been found that gage heights become so affected by ice that in the vast majority of cases the open-water rating curve cannot be applied. Also it has been found that gage heights to water surface have in almost all instances no constant relation to the discharge. Thus it has been impossible to obtain winter records of daily flow by the simple methods of the open season. The much less cost of maintaining stations of this kind over those of the dam type, however, constitutes a sufficient reason for studies to devise a simple method of obtaining records at such simple gage stations during the frozen season.

Experimental Data.

In order to study the effect of ice cover, the author collected information at 20 river stations of the U. S. Geological Survey, located from the Atlantic Coast to Wisconsin. These data were collected for river stations which gave satisfactory results during open season. Of the 20 stations 4 had winter records of stream measurements continued for several years. These four records are given in Table I.

The limitations of the present article do not permit the presentation of the data for the entire 20 stations. The point brought out most conclusively by them was the lack of a definite relation between gage heights and discharge. To explain this let the "coefficient for reducing open water to ice conditions with gage heights to water surface" be denoted C; and the "coefficient for reducing open water to ice conditions with gage height to bottom of ice" be denoted C'. The extreme range of C as tabulated was from 0.11 to 1.11. The extreme range of C' was from 0.12 to 3.65. For the four stations tabulated herein the extreme range of C is from 0.15 to 0.83 and the extreme range of C' is from 0.41 to 1.16. It is noticeable that while the range in C is large, it is in both instances less than the range in C'.

To indicate this more fully the above Table II. is inserted.

Of these 20 stations, there are 14 in which the range in C, and in C' can be compared. Of these 14, there are 12 in which the range in C is less than in C'. The difference in C for individual stations ranges from 0.04 to 0.63; while the difference in C' range from 0.05 for the best to 1.98 for the poorest. Taking the average for 14 stations, there results for differences at individual stations for C, 0.248, and for C', 0.636. Taking average values of C and C' for each of these 14 stations and averaging them, there results for C, 0.419, and for C', 0.950. The percentage average deviation of C from this mean for individual stations is 59.2%, and of C', 66.9%.

In all of these comparisons C has been found to be more uniform than C', indicating that there is a more constant relation between discharge gage height to water surface than there is between discharge and gage height to bottom of ice.

Attention has been called to this comparison because in the past it has been a topic of considerable discussion.

Control Points.

No further deductions have been attempted from the tabulated data. They do not point to any well-defined law, but instead they accentuate the diversity of conditions during the frozen season. A theoretical study of conditions, however, leads to certain fundamental principles. In the first place, it may be said that streams are determined in water-surface elevation by a successive number of what we may call "control points" varying more or less in number and in position as the river stage changes. These control points may be dams, natural falls, rapids, bars, on stretches of constricted cross-section. They act in the general nature of weirs; that is to say, the water-surface elevation for the stretch above a control point is determined by the height of water at the control point, and is so determined up-stream to the next control point. The extreme case of this and the most simple is in a stream which consists of a series of dams and mill ponds. In this extreme case the rule just stated is very evident, and it will be readily granted that the water surface in each mill pond is determined by the water height at the dam.

Conditions During the Frozen Season.

During the freezing period ice at first forms at the shores and gradually extends out across a stream until it has made a complete ice covering, which continues to thicken as cold weather continues. With thawing weather this ice cover gradually diminishes in thickness, but it seldom becomes melted much before it is carried out by high water of mid-winter or spring floods. In the first case, a new ice cover is likely to replace the old; freezing taking place in exactly the same manner as before.

Rarely, if ever, in this country does a stream of any size freeze over throughout its entire length, there being usually short stretches that remain more or less open, especially at those places where the velocity of the current is great.

The most important thing about this ice cover, as far as winter estimates are concerned, is the extent to which it is in flotation. It is evident that if the ice cover only extends part way across the channel it is not strong enough to support itself as a cantilever, and consequently must be in flotation. If the ice cover extends wholly across the stream it is either in a state of flotation or else acts like a beam supported at both ends. Considering a strip of unit width to be taken across the stream, it is possible to estimate how great a change in gage height is necessary to cause this beam to fail.

Considering the gage height to be at the position where the ice is in flotation, there is evidently no force tending to cause the ice cover to fail. But suppose the water surface to either rise or fall: In either case there is at once a pressure brought to bear upon the ice cover; in the first instance it is an upward vertical force equal to the weight of water displaced by the change in gage height and in the second is a downward vertical force of equal intensity. By obtaining values of the unit strengths of ice it is possible to compute tables for streams of various width with various thickness of ice showing the change in gage height necessary to cause failure of the ice cover and produce perfect flotation.

The unit strengths of ice have not been exactly determined. Approximate values have been taken from the following literature* furnished through the courtesy of Prof. Charles M. Spofford, of the Massachusetts Institute of Technology.

A report of a Thesis by the students at the University of Illinois, published in Vol. 9 in the "Technograph."—These tests showed an average crushing strength of 1,450 lbs. per sq. in., the tensile strength being 165 lbs. per sq. in. These tests were made upon ice of unusually good quality and were conducted at a low temperature.

Engineering News of Dec. 26, 1885, quotes some experiments by Fruhling.—The following results were obtained: Tensile strength at 23° F., 180 lbs. per sq. in.; compressive strength at the same temperature, 150 lbs. per sq. in. Beam tests at 37° F., 120 lbs. per sq. in.

A Thesis by students at the Massachusetts Institute of Technology written in 1905.—The results of the tests may be briefly summarized as follows:

Compressive strength of natural ice at a temperature just below freezing was found to vary from 84 lbs. per sq. in. to 683 lbs., with an average value, from 46 specimens, of 176 lbs. Shearing strength of which only four tests were made, varied from 69 lbs. to 97 lbs. per sq. in., with an average value of 86 lbs. Bending tests made upon beams with spans from 10 to 13 ins. gave values for the modulus of rupture averaging from 44 lbs. per sq. in. to 347 lbs., with an average value from 11 specimens of 167 lbs. per sq. in. These tests were made with the temperature of the outside air at 55°.

Mean values are taken as follows: Tensile strength, 160 lbs. per sq. in. Shearing strength, 86 lbs. per sq. in. Table III. gives rupture figures for streams of different widths.

TABLE III.—CHANGES IN GAGE HEIGHTS REQUIRED TO RUPTURE ICE ON STREAMS OF DIFFERENT WIDTHS.

Thickness of ice, ins.	Change in gage height to cause rupture, ft.
Stream 500 ft. wide.	
6	.0005
12	.0015
24	.0077
36	.0172
Stream 200 ft. wide.	
6	0.003
12	0.012
24	0.048
Stream 100 ft. wide.	
6	0.012
12	0.048
24	0.191
Stream 50 ft. wide.	
6	0.048
12	0.191
24	0.766

The figures in Table III. indicate that in a large majority of cases ice upon frozen-over streams is actually in flotation. Additional evidence lies in the fact that the water surface in a hole cut through the ice cover is ordinarily just below the top of the ice; when the ice is not covered deeply with snow. The weight of ice is from about 57.2 to 57.5 lbs. per cu. ft. The weight of water at 32° F. is about 62.4 lbs. per cu. ft. The ratio of the weight of water at 32° F. to the average value of 57.35 for weight of

*[See also Engineering News, May 20, 1910, p. 560. —Ed.]

ice is 1.088; indicating that for floating ice 12 ins. thick there is about 1 in. from top of ice to water surface.

Theory of Flow Under Ice Cover.

Considering the two facts that control points determine the water-surface elevations, and that ice cover is ordinarily in flotation it follows that the usual change produced by the appearance of an ice cover is to cause a general increase of water-surface elevation without increased flow.

The ice cover increases the friction of the wetted perimeter of the flowing stream, causing the water surface slope between control points to be increased. The increase is greater in rapidly-moving streams, and being practically zero in streams of small mean velocity and short distances between well-defined control points.

In the special case of a weir and pond the result is to cause no increase in water surface above and near the weir.

Let it be assumed that a gage has been installed above the weir and a rating table obtained for open-channel conditions. A moment's reflection will show that this rating table is not affected by floating logs or other material in the pond above the weir; the reason being that gage heights are determined only by the height of water required at the weir to pass the discharge over the weir. If this floating material is ice, it has no effect upon gage heights, so we can lay down the rule that under such conditions the open-water rating table will apply equally well where there is ice cover. Incidentally, it is noticeable that a gage height to the bottom of the floating ice depends upon the thickness of the ice, as well as upon the discharge.

Extending this principle to rivers, it is evident that the same law will hold wherever the control point is well defined, when it is free from obstruction and when the ice cover from the gage to the control point is in a state of flotation.

Where this is not the case, where the control point is still well defined, and the ice in a state of flotation, but where the control point becomes partly clogged with ice, the open-rating table does not apply. But another table does apply wherein the gage height to water surface is still applicable.

When the control point is not well defined, when ice obstructs the flow past it, and when the ice is not in a state of flotation at the gage, this principle applies less exactly until a point is reached where gage heights to water surface do not have a simple relation of the discharge.

The conclusion is that whenever gage heights are used as a basis of winter estimates under ice cover, these gage heights should be to water surface, and will apply only where stations are favorably located.

Test of a Satisfactory Station.

Returning to the above general table of winter data, it is noticeable that there is a wide range in the value of C for different stations. If a station fulfilled the theoretical conditions having a well-defined control point, free of obstruction and with floating ice cover, C would be unity. If the control point became obstructed C would be reduced; if poorly defined it would become obstructed more rapidly than otherwise. So it is true in general that the nearer C is to unity the better is that station for obtaining winter estimates. Also the nearer C is to unity, the more constant is it likely to be. Thus C becomes a test to apply to present stations to determine in how far they are affected by ice and to determine which of the following methods should be applied in making estimates.

Methods of Making Winter Estimates.

Three methods of making winter estimates of flow will be given, in the order of efficiency: Method A is based upon the theoretical discussion just given, and is recommended for present river stations where C remains at or near unity, and for new stations which may be installed in the future.

The important consideration for such stations is to determine the location of the gage with the best judgment. It should be above and close to a well-defined control point that will remain fairly clear of obstruction and should be placed at a section where all ice between it and the control point will be in a state of flotation.

Then mean daily gage heights may be applied to the open-water rating curve. Measurements of discharge may well be made once or twice during the winter as a check.

A station closely approximating these conditions is that of the U. S. Geological Survey at Piercefield, N. Y., established by the author in August, 1908.

This station is located at the head of Black Rapids, about one-half mile down-stream from the dam of the International Paper Co., in the town of Piercefield.

There is one channel at all stages. Discharge measurements are made at low and medium stages by means of a boat fastened to a wire, stretched immediately above the head of the rapids. During high water, measurements are made from a highway bridge above the paper mills.

The gage is located about one-half mile above the rapids in the pond which extends from the paper mills to the rapids. Ice forms in this pond to a depth of 2 ft. at times. The rapids remain open the entire winter and are usually free from any ice obstruction.

The open-water rating curve has been found to apply for winter as well as summer conditions.

It is well to emphasize the fact that such stations may be found. The great majority of present stations do not satisfy the necessary conditions for this method; but in a great many cases stations could be found in the same vicinity that would do so.

The important factor is to select winter stations with great care and good judgment, keeping in mind the necessity of a well-defined control point, with either absence of ice extending up-stream to the gage or else ice which will be in flotation.

It is well worth while to spend time in reconnoitering for such stations; for they will save in a single winter the cost of several gagings which may easily exceed the expense of reconnaissance.

This method may be applied to established stations in the same locality, by using an auxiliary gage, after the regular gage has been found to be affected by the formation of ice. This auxiliary gage may be placed at a well-defined control point, and afterwards rated, by simultaneous readings with the previous gage during the following open water season. Many times the conditions at such an auxiliary gage, such as rough water, may preclude readings of great precision, in which case it may be desirable to adhere to the original gage during open season, and use the auxiliary gage only after the freezeup.

METHOD B.—Method B is recommended for those streams where it is impossible to obtain satisfactory control points. In many cases it is believed that C will remain near unity if the station is carefully selected and that C can be applied, if checked by frequent discharge measurements. However, in the early part of the freezing season it is better to adhere to method B until C has become constant.

To illustrate the basis of this method consider the cycle of events during the freezing period. During this time the discharge of a stream ordinarily remains very nearly or quite constant. Any precipitation during this period is usually in the form of snow, and consequently does not materially increase the discharge. During this period, however, there very often occurs a decided increase in gage height, in stations of this class. This is caused by ice forming at the control point, or between it and the gage, and the suddenness and magnitude of the increase in gage height is an index to the extent to which ice has caused obstruction at the control point and above. At the same time, ice may or may not form in the vicinity of the gage. Ordinarily after a certain period of a few days during which the discharge is nearly constant ice conditions become fairly stable and the gage height does not continue to increase rapidly. As winter progresses the ice cover slowly thickens, the coefficient C has a tendency to slowly reduce, and the discharge often gradually diminishes, although this is by no means universal. In the spring there is usually a sudden breakup. The discharge rapidly increases to flood stage and with the passage of the ice C returns to unity.

Method B is based upon this cycle of events and is practically a series of discharge measurements. It consists in making a discharge measurement as soon as freezing commences as evidenced by the rising gage heights unattended by any reason for increased flow. A second measurement of discharge is then made as soon as the ice cover becomes permanent. Afterward discharge measurements are made whenever the gage height to water surface indicates a considerable change of discharge. Between discharge measurements estimates of flow are made by interpolation and not by the use of gage heights.

On many streams, thaws occur in mid-winter causing considerable increase of discharge, and occasionally carrying out the ice. At such stations, of course, more numerous gagings will have to be made, the number depending wholly upon the number and intensity of the thawing periods. On such streams it is highly desirable to locate the gage according to Method A.

METHOD C.—The third method is to use stations of the dam type, computing the flow as the sum of discharge through water wheels, through wasteways and over spillways. The procedure is to keep the wasteways and spillways free from ice obstruction, so that open water ratings may be applied. If this procedure is impossible, it is necessary to rerate these wasteways and spillways as often as ice conditions change to any great extent. Many spillways, for example, become covered with a mass of ice, because of inattention to them, and weir formulas no longer apply even approximately. At best this third method is very laborious, and in the majority of cases will probably produce results of less accuracy than either of the two previously stated.

Elimination of Railway Grade Crossings in Cleveland, O.*

By ROBERT HOFFMAN,† M. Am. Soc. C. E.

Grade crossing elimination work began at Cleveland about 14 years ago, when East 55th St. (then called Willson Ave.) was elevated and carried over the tracks of the New York, Chicago & St. Louis Ry. This crossing had long been looked upon as dangerous, the railway tracks crossing at the foot of a steep approach, and being further complicated by an existing street railway track. An amount of $10,000 was contributed by the street railway company. This is the only case in the city where a street railway company has made any direct contribution towards the expense of eliminating a railway grade crossing.

In 1902 and 1903, a more active campaign was begun by the city and all the railway companies were called upon to present plans for grade eliminations according to law. Since that time, the various crossings have been eliminated as fast as the plans and terms could be mutually agreed upon, and as the city could procure the necessary funds to pay its portion of the cost. Many more crossings are still to be eliminated. Those where the highway is used for street railway traffic must be considered the most dangerous, and consequently the most urgent for early treatment. As in many cases, the railway grade must be raised or depressed, as well as the highway grade changed, it is often not practical to abolish one crossing at a time, but requires the consideration of a group of streets. The progress of the remaining work depends largely upon the cooperation of the railway companies and the speed with which the agreements relating to the work can be obtained by the city.

GRADE CROSSING LAW.—Should the railway companies refuse to cooperate, or should no agreement regarding plans and division of cost be reached, the statute fixes a method of procedure. The grade crossing law provides that municipalities may raise or lower the grade of any street, or may order the raising or lowering of railway tracks in order to separate grade whenever the council or other legal board of legislation may declare the same necessary.

Municipalities may also relocate and vacate streets

*Abstract of a paper read before the Cleveland Engineering Society, and published in the December number of the Society's "Journal."

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where such action is declared necessary. The council may order, by ordinance, that railway companies cooperate with the engineer of the municipality and submit plans and specifications within three months (or longer if mutually agreed upon) specifying street grades, railway grades, kinds of structures and method of erecting, also, whether supports or abutments are to be located in streets. No change, however, in the railway tracks shall be made that exceeds the ruling grade of the railway.

If the railway company fails to cooperate or, in case the plans and agreements are not mutually approved, the municipality may submit the matter to the Court of Common Pleas. An opportunity is then given by the Court for either the company or the municipality to submit plans for grade elimination. The court may then pass on plans, order changes or refuse plans; it has also the power to enforce the work.

The division of cost is provided for by statute. It was formerly divided equally, but was changed, at the last session of the legislature, so that the company must now assume 65% of the cost, and the municipality 35%.

Provision is made for the payment of damages to owners of property affected by reason of change in street grades. Power is given to appropriate land. The municipality must pass a resolution or ordinance setting forth its intention to do the work and establish the manner of paying damages. Notice of such intention is served upon property owners supposed to be affected, thus giving them time to file claims for damages. Grades of streets changed must also be re-established and notice served.

The grade-crossing law also establishes the clearance of bridges over railway tracks as 21 ft., but provides that by mutual agreement or court order, this clearance can be reduced, but cannot be made less than 16 ft. 3 ins.

The statute provides that the company shall maintain all bridges carrying the railway over the highway, and the municipality shall maintain all bridges carrying the highway over the railway, together with the street approaches.

Bonds may be issued to defray the municipality's portion of the cost, but such bonds may not be sold at less than par, and shall not bear interest to exceed 4%. Taxes may be levied to provide for payment of bonds and interest, and also to provide for necessary maintenance and repair. Street railway companies may be made to pay not to exceed 50% of the municipality's share of the cost.

CONSTRUCTION WORK.—The engineer has often an exceedingly complicated problem, even when only a single crossing is being treated, but the problem becomes many times greater when an attempt is made to prepare plans for the elimination of the crossings of an entire city like Cleveland, traversed as it is by several railways. These roads cross each other and provision must be made for connecting lines and also for the separation of grades at certain railway crossings. These conditions, together with ruling grades of the railways, are basic things to be considered. Add to these the maintenance of railway traffic, as well as highway traffic, the encountering and relocating of numerous underground improvements, such as sewers, water pipes, gas pipes and electric conduits, the question of drainage and beauty of architecture, and there results a problem which requires the best ability of both railway and municipal engineers.

In making the general plan for grade elimination along the line of any railway, one of the first questions to be considered is, whether the tracks should be raised or lowered. Judging from local experience, it is doubtful whether one could determine which plan is the better. From the railway point of view it is almost wholly a problem which must be decided in each case, and not a matter of policy. It would naturally adopt that plan, which, all things considered, would prove the most economical.

From the city's standpoint, the economy of first cost has some weight, but much less so the economy of railway operation. The noise and smoke from such operation do, however, seriously affect the public interest and it is quite generally agreed that all steps are warranted which tend to reduce these two evils to a minimum. Many feel that this can best be done by sinking the railway tracks as low as possible. There are certain locations, where perhaps a railway track at any elevation is unsightly, and where lowering the grade for that reason alone would be desirable. Railways, however, are built and operated to do business and not merely to refrain from becoming a nuisance, so that any plan of treatment must keep in mind all the practical sides of the problem, and no hard and fast rule that tracks should be either raised or depressed should ever be drawn.

The work must be done in such manner that traffic on both the railway and highway can be maintained. At the best, the traffic must be subject to interference, business in the vicinity of elimination work may be affected and as a consequence much criticism heaped upon those directing the work. Some of the criticism may be merited, as it is quite natural that the progress of the construction work should appeal more strongly to those in charge than the ease and comfort of people who wish to pass the work. Engineers will appreciate the difficulty of always making work of this kind run smoothly, where, in addition to the work of the contractor and the maintaining of traffic, there must also be considered the property of a street railway company, the pipes of the gas companies, the wires and conduits of two telephone companies and an electric light company, and in many cases the city sewers and water pipes.

It seems almost impossible to make the work of the various interests follow logically without annoying delays. Where possible, a considerable outlay is warranted in providing a temporary roadway at some other location, and this has frequently been done. In many cases such a temporary detour is not feasible and the public must needs be patient and realize that the interruption to traffic is necessary and in a good cause.

In the Cleveland work solidity has been striven for and designs made so as to insure a low cost of maintenance. Railway bridges have been specified to have solid floors of steel and concrete with ballasted tracks. Highway bridges have been built so as to permit the laying of a brick or stone paved roadway. Supports at the curb lines have been permitted at a number of places for overhead railway bridges. This was to avoid the excessive depth of girders required in certain long spans, making possible a saving in expense as well as producing a more pleasing appearance by establishing a better relation between depth of girder and the clearance above the roadway. Otherwise the roadways have been kept clear, no supports at the center of the roadway having been allowed.

Clearances over highways have been varied from a minimum of 13 ft. to 14½ ft., where street railway tracks made the greater clearance necessary, but the engineer of maintenance of the street railway company claims that 15 ft. should be the minimum. It is probable that this clearance will be increased to 15 ft. in the future work. Wherever possible, clearances of highway bridges over railway tracks have been fixed at 21 ft., the maximum required by law, but along the line of the N. Y., C. & St. L. Ry., on account of highway approach complications, the minimum of 16 ft. 3 ins. was adopted.

The approach grades vary with local conditions and it is endeavored not to introduce heavier grades than those in use in the vicinity of the bridge. In general, it is attempted to keep within a maximum of 4%. In a few cases, 5% grades were used and in two cases 6%.

In general, surface improvements on the approaches, such as paving and sidewalks, are relaid with material similar to that existing before the change in grade. The old material is used to some extent, but most of it is new. In cases where the new grade is 4% or greater, no matter what material has formerly been used, it has been the custom in repaving to use block stone.

Nearly all of the bridge abutments and retaining walls in the grade elimination work have been built of concrete. The structures seldom present as pleasing an appearance as is possible with block stone masonry, and unsightly crazing, cracking and discoloring has taken place in nearly all cases. It must be conceded, however, that progress is being made in concrete finishing and that some of the more recent work now in progress shows a decided improvement in this respect.

Nearly all grade crossing bridges have been made strikingly utilitarian. Probably more attention should be paid to the obtaining of artistic lines in bridges, abutments and retaining walls. It costs but little (if any) more to build walls with panels and copings properly proportioned, or to design girders and trusses with proper regard to a pleasing and artistic outline. Public work should be made so as to set an example in construction and should, therefore, be so designed that it is beautiful to look upon and creates an impression of solidity and security.

Where the level of the street is changed to conform with the plans of the crossing elimination, it frequently leaves improved property either so much higher or lower than the new grade, as to affect the value detrimentally. Damages are usually adjusted after the work is completed, the time of such adjustment being fixed by council resolution, which is referred to in the notice served upon property owners.

There is a great opportunity for difference in judgment in fixing the amount of damage which a given piece of property is entitled to, by reason of change of grade. In some cases, nearly the entire value is destroyed, as it may involve a relatively great expense to raise or lower buildings, fill or excavate lots or otherwise readjust matters to suit the new grade.

Several items like loss in business during construction, or loss in value, due to traffic being so diverted that it no longer passes in front of or near a piece of property, are not considered in law as valid claims for damage allowance. There must be a change in grade of the street upon which the property abuts, or else some other direct physical change due to the improvement in order to entitle property to any consideration for damage allowance.

The general effect of a so-called grade crossing improvement is ordinarily favorable upon the land in its vicinity, after time has been given for the changed conditions to adjust themselves. No account is taken of this general benefit as an offset to damage claims.

The city has expended for grade crossing purposes about $1,070,000. The estimated cost of $175,000 as the city's share of abolishing the West 25th St. crossing makes a total of $1,245,000, paid as the city's portion of the cost of eliminating 16 crossings. This makes an average cost of about $78,200 per crossing. This average takes into consideration certain crossings that were abandoned, the streets being connected with others in the vicinity and a combined crossing at the railway tracks provided. Each such street is counted as an eliminated crossing. The work so far done has involved complicated, expensive cases, and also some that were reasonably cheap and simple. The estimate given can, therefore, be used as a fair average.

Changing this average cost to suit the rate of 35% which now represents the city's portion of the cost of grade crossing work, the cost for future work would be $54,740 per crossing. This would yield a total sum for the cost of the 146 remaining crossings of nearly $8,000,000. There must be added to the city's expense that of the railway company, which by law is made nearly twice as great. Railways, when eliminating grade crossings, also frequently take the opportunity to make certain betterments, the cost of which is not shared by the city, so that it is safe to say the total sum to be expended in connection with grade elimination in Cleveland, based upon present conditions, will amount to over $24,000,000.

DISCUSSION.

A. J. Himes.—We are planning to remedy an evil, but not to remove the cause. We should by all means eliminate the grade crossings, but where is the end to be? If Cleveland has one million population in 1920, its limits will reach out towards Lorain and Willoughby and where is to be the end of our work?

F. E. Bissel.—A railway passing through many cities and towns, must consider the demands of any municipality not as an isolated case, but as one of the many cases existing along its line. The municipal authorities seldom look beyond their corporate limits and fail to appreciate that other towns and cities are making similar demands and to grant them all is beyond the financial ability of any railway.

The railways are willing to eliminate many grade crossings of their own volition, whenever they can do so without extraordinary expense. The state of Iowa has no legislation on the subject, yet up to June 30, 1908, the railways had eliminated 751 grade crossings. In Vermont, each railway is required to eliminate one grade crossing each year for every 80 miles of road. In Connecticut, it is one grade crossing each year for each 60 miles of road. In Massachusetts and Virginia, a state commission orders what grade crossings shall be eliminated and also approves the method by which it shall be done.

Not all grade crossings are, by any means, the voluntary creation of the railways. The locating engineer reaches a town which has offered free right-of-way as an inducement. To please the people and to get through the town with as little friction as possible, the engineer locates the line as the people desire, which, in many cases, is down some back street, which helps the town in the cost of the right-of-way. The street is duly vacated for that purpose by a unanimous vote of the city fathers and with the consent and approval of everybody. The town having railway facilities, grows and expands. The early citizens pass away and a new generation suddenly asks the railway what it is doing there, occupying a street, invading the people's rights; it demands forthwith track elevation and grade crossing elimination and all at the expense of the offending road.

A railway projected a line through a town in Pennsylvania, eliminating all grade crossings, but the citizens protested, and the railroad at considerable expense changed its line so it could pass through at grade. But the time is fast approaching when that town will demand that the road elevate its tracks and pay all the cost of such change even though the condition is the result of the expressed wish of the citizens.

If the decision of the Massachusetts State Commission in the matter of grade crossing elimination at New Bedford were made the basis of all negotiations, it would be better for all concerned. In that case the commission insisted that the cost be kept down to the lowest figures compatible with standard railway practice and a fair substitution for what both the railway and the city then enjoyed, and decreed that the railway should be elevated and pass over the streets on structures proportioned and constructed in accordance with its general specifications for railway bridges.

At one time I prepared a plan, which called for supports at the curb line of the street. There was a vigorous protest, but in a cursory examination of the streets, there was found to be at the curb line, or within 2½ ft. of it, the following: Trolley poles, telegraph poles, telephone poles, electric light poles, fire alarm poles, flag poles and barber poles, besides hydrants, street lamps, awning supports, mail boxes, waste paper boxes, police call boxes, street signs, business signs, hitching posts, horse blocks and shade trees.

My experience is that the smaller the town, the greater the objection to supports at the curb line. New York has supports at the curb line. Chicago has supports at the curb line and also in center of the street. In Philadelphia, all crossings on the Philadelphia & Reading Ry., 32 in all, have posts at the curb line and many have also a support in the center of the street.

Road Building in New York State; With Additional Data on Top Courses of 2-in. Cubes of Clay and Concrete.*

By W. G. HARGER.†

In the effort to meet the demands of automobile traffic, the present tendency of road men, in New York State at least, seems to be towards tar and asphalt binders. They have tried Kentucky rock asphalt, tarvia, vitovia and other surface treatments, and at present have adopted for practically all their roads a residuum bitumen or asphalt binder, acting through the full depth of the top course and applied by what is known in New York State specifications as the grouting method. All these methods are good if carefully worked out, but each has some constructional difficulties, and the fundamental objection that a great part of the material has to be shipped or hauled from a distance. Kentucky rock asphalt, being a natural product, is liable to be uneven in quality. It is hard to handle in cool weather, gives a slippery footing during storms of sleet and disintegrates in spots. The cost of top course has been approximately 70 cts. per sq. yd.

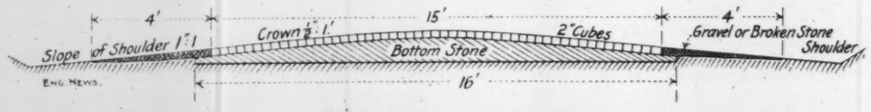

FIG. 1. ROAD SECTION SHOWING TOP COURSE OF SMALL CLAY OR CONCRETE CUBES.

(The extension of the bottom course beyond the top cou rse and the use of gravel shoulders is to prevent the cubes from breaking down at the edge.)

Tarvia and vitovia surface treatments have been more successful than the rock asphalt and it is still a question whether or not they will not prove as good a construction as the bituminous macadam. They give a good footing but are liable to wear in spots or peel off on account of frost, leaving a rough patchy top. The cost of the top course, using 3 ins. of stone, is approximately 50 cts. per sq. yd. Water-bound macadam roads, treated with a light road oil and covered with screenings, are nearly ideal in dry weather, but have the serious objection of giving in wet weather an oily mud, which is hard on vehicles and ruinous to clothing.

The present bituminous macadam gives a good footing under all conditions, apparently wears evenly and is easily repaired, but it requires rigid and unusually intelligent inspection to insure a uniform result. It cannot be laid in wet or cold weather, and thus its use cuts down the construction season by at least a month under that for the old water-bound road. It has the added disadvantage that the supply of residuum bitumen and asphalts is apparently controlled by the Standard Oil people, who have raised the price from 8½ cts. per gal. f. o. b. western New York in 1909, to 9½ cts. in 1910, with the prospect of another raise in 1911. If the tendency towards this style of road to the exclusion of all other forms of construction is as strong throughout the country as it is in New York State, the price is sure to rise. The price of bituminous macadam has been approximately 40 cts. per sq. yd. for a 2-in. top course and 60 cts. for a 3-in. top.

To meet the difficulties of a short construction season, the probable advance of asphalt prices, and the high cost of top course due to excessive freight and haul of stone, the New York State Highway Commission is building, under the supervision of Mr. J. Y. McClintock, the originator, an experimental piece of road near Rochester, N. Y., using a top course made of 2-in. cubes placed by hand on an ordinary macadam bottom course and filled with sand or sandy loam. A sectional view of this construction is shown in Fig. 1. The cubes can be made of stone or gravel concrete, vitrified shale, brick, local clay mixed with ashes and burned, or even stone blocks.

Each of the above named styles of cubes has been laid except the stone blocks. A stretch one third of a mile long has been in use for a year and has proved conclusively that the cubes give a good footing, do not ravel or break down at the edges, and give a clean surface in both wet and dry weather. The points that particularly appeal to a constructing engineer are the facts that wet or cold weather does not stop construction and that rigid inspection in laying is not necessary. The facts that appeal to the designer are that he can use local materials in many places where at present imported stone is needed and that he can scientifically arrange his material by placing tougher cubes in the center of the road and softer and cheaper ones on the sides. The actual cost of this top, including material and placing, has been 50 cts. per sq. yd. for concrete cubes and $1.10 per sq. yd. for clay cubes. The price compares favorably with bituminous macadam, provided the wear is not more rapid. The success of the cubes has been demonstrated on all points except wear. Apparently they are standing the traffic satisfactorily; but if they do prove too soft, it is a simple matter to use a harder material and the results are so promising that they certainly warrant a thorough trial of the cubes under all conditions.

Concrete Guard Rail.

It may be mentioned incidentally that the maintenance of wooden guard rails is getting to be a serious item. Fig. 2 shows a drawing of a concrete guard rail put up on this same experimental road in the effort to get a strong, permanent rail for a reasonable first cost. It costs 50 cts. per lineal foot in place, is designed for a six-ton load in the center of the span and will require practically no maintenance. This rail looks well and is particularly well adapted for a combination bridge and guard rail. The old design of an iron bridge rail abutting on a wooden road rail was always an eyesore. The rails and posts are molded separately at some convenient place and allowed to set for at least a month. They are then put together in much the same manner as the wooden rail.

McClintock Cube Pavement.

For the convenience of those who will have no opportunity to see the 1910 Report of the New York State Highway Commission, there are given below some details of the methods and cost of manufacturing and laying the cube pavement.

CONCRETE CUBES.—The concrete cubes have been made by machine and by floor molds. The accompanying picture of the machine (Fig. 3) is self explanatory. Sixty-eight cubes are made at one operation. A gang of eight men mixing by hand for the molding machine will turn out an average of 25,000 cubes a day, equivalent to 100 sq. yds. of surfacing. The cubes are taken from the machine on a wooden tray, set in drying racks for 24 hours, and then piled and seasoned for at least three months; during the seasoning process they are thoroughly wet down twice a day. Approximately 2 bbls. of cement are used per cu. yd. of concrete, which makes 5,500 cubes. The labor cost was $3.50 per cu. yd., and the total cost for labor and materials $6.60, making the cost at the factory $1.20 per thousand cubes or 30 cts. per sq. yd. of road surface. This is not a fair figure for large-scale operation, where by the use of machine mixing and other labor saving devices a reasonable estimate would be $4.50 to $5.00 per cu. yd. or 20 to 25 cts. per sq. yd. The concrete must necessarily be stiff for the machine molding and the cubes are consequently not as dense as floor-molded cubes, but are more uniform in size, and therefore cheaper to lay.

In most cases the floor-mold method is more convenient and will usually give better results. The molds are made of 2-in. hoop iron, 1/16-in. thick, bent as shown in the accompanying sketch (Fig. 5) and held in place by wooden strips at the sides. They were dipped in form oil to prevent adhesion. On a floor 16 × 80 ft., 30,000 cubes were molded at one time. The proportions of the concrete were the same as for the machine, but a wet mixture was used and the filled molds thoroughly tamped, giving a dense product. The cubes were allowed to set 24 hours and were then piled and seasoned. The cost by this method was practically the same as for machine work.

The cubes are loaded, hauled and dumped like broken stone. They are laid by hand on a sand cushion ¼-in. to ½-in. thick, no care being taken to break joints or fit them too closely. They are then rolled to bring to an even surface and firm bearing; a layer of sandy loam is spread on top, broomed, and flushed in, preferably with a pipe line and hose; the course is again rolled, the wearing surface of sand placed, and the road opened for traffic. Temporary shoulders of 2-in. plank are put down during the laying of the cubes, after which they are removed and replaced with broken stone or gravel as shown in Fig. 1.

The cost of laying and manipulation was 7 cts. per sq. yd.; the cost of carting will be about the same as is usually estimated for stone and on this particular stretch it was 3 cts. per sq. yd. for a quarter-mile haul including the cost of loading. The shoulders were built for 26 cts. per sq. yd., including materials and labor, which latter amounts to about 13 cts. per sq. yd. of cube surfacing or 21 cts. per lineal foot of road. The cost of laying can probably be reduced to 4 cts. or 5 cts. per sq. yd. on a larger job, but the writer does not believe that the shoulders can be built much cheaper.

The cost of the gravel concrete cube surfacing is summarized in the New York State Highway Commission report of 1909 as follows:

Cement, 0.088-bbl.	$0.121 per sq. yd.
Cost of factory	0.107 " " "
Labor of manufacture	0.161 " " "
Gravel (50 cts. per cu. yd.)	0.024 " " "
Carting	0.027 " " "
Laying	0.072 " " "
Total	$0.512 per cu. yd.

Note: Labor at 22 cts. per hour.

The charge for factory is, of course, high for a short piece of road. Under ordinary conditions it is safe to say that this top course could be estimated at an actual cost of 40 to 50 cts. per sq. yd., in place, or a contract price of from 50 to 60 cts.

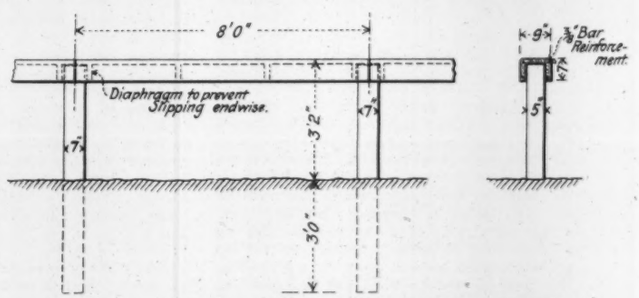

FIG. 2. CONCRETE GUARD RAIL FOR RURAL ROADS.

(Posts are 5 × 7 ins. and 6 ft. long, reinforced with 4⅜-in. square rods near the corners. The rails are merely set on top of the posts without fastening.)

VITRIFIED SHALE CUBES.—During 1909, 74,000 2½-in. vitrified shale cubes manufactured at Reynoldsville, Pa., were laid in this same manner. The larger size did not seem to give as good a surface as the 2-in. size. The cost of the vitrified shale cubes was as follows:

*An earlier account of the experimental road of this construction was published in Eng. News, March 3, 1910. The present article gives further details of the manufacture of the cubes, further cost data and some account of the condition of the road after a year's service.—Ed.

†49 Vick Pk. "B," Rochester, N. Y.

Teams at 50 cts. per hour.	
1,000 cubes f. o. b. Reynoldsville	$231.25
Freight	68.41
Carting	67.00
Laying	20.00
Total	$386.66

Note: 331 sq. yds. were covered at a cost of $1.17 per sq. yd.

CLAY AND ASH CUBES.—In 1910, cubes made of a local clay mixed with ashes and burned were tried in the effort to get a cheap, tough clay product. As far as known this is the first time bricks made in this way have been used on road work. The ash-clay process has been worked out and patented by Mr. Karl Langenbeck of Boston. Many local clays used for ordinary brick or farm tile will not stand up under vitrification without the addition of expensive, imported, refractory clays; but by the substitution of coal ashes for the more expensive clay, the same result is obtained and the cost is materially reduced. Some of the local clay was sent to Mr. Langenbeck, who turned out a few cubes that compare favorably in toughness with the best paving bricks on the market.

FIG. 3. MOLDING MACHINE FOR CONCRETE PAVING CUBES.

The Standard Sewer Pipe Co. of Rochester undertook to furnish 400,000 2-in. cubes of this description for Mr. McClintock. It was necessary for them to experiment to determine a practical method of molding, the correct temperature to use and the best proportion of ashes, which naturally raised the price above ordinary practice. In molding they used a modification of the ordinary pipe molding machine, which produced a hollow square of cubes, as shown in Fig. 4, at the rate of 30,000 cubes per hour. The scoring knives were so set that the cubes were nearly cut apart, leaving just enough uncut clay to hold them together during the burning, after which a light blow separated them cleanly. The toughness of the resulting cubes can probably be increased by further experiment; but the product was good, although not up to the standard of the sample cubes made by Mr. Langenbeck.

The cost of the ash-clay cubes was as follows:

400,000 cubes f. o. b. Rochester	$1,200.00	$0.711	per sq. yd.
Carting, six miles	247.75	0.147	" " "
Filler	27.00	0.016	" " "
Labor of laying	191.77	0.113	" " "
Roller	12.94	0.008	" " "
Total	$1,679.46	$0.995	per sq. yd.

Note: 1,688 sq. yds. covered.
Labor, 22 cts. an hour } For laying and carting.
Teams, 50 cts. an hour }

Mr. F. G. Sweet, Manager of the Standard Sewer Pipe Co., has stated in discussing the cost, that in large quantities he believes the cubes can be delivered f. o. b. at the plant for $1.50 per thousand, which would reduce the cost as shown above to about 65 cts. per sq. yd., and that the high cost of laying was due to the irregular shape of the first batch due to not scoring the cubes deeply enough.

Conclusions.

There are any number of materials and possible variations of method in their use which will have to be tried out before any classification can be made of the best and cheapest cubes for different local conditions, but in the broad principle of a 2-in. cube construction Mr. McClintock certainly seems to be on the right track. Anyone familiar with road work subjected to the climate of the Northern States knows that a top course laid on a macadam foundation must be flexible; the cube construction fulfills this requirement. Ohio has had some expensive failures near Cleveland in attempting to put paving brick on such a foundation. Paving brick on a concrete foundation is too expensive for most roads and can be left out of consideration except in unusual cases. Sheet concrete surfacing, even of considerable depth, has not proved as satisfactory as hoped for. Bituminous macadam, as stated in the first part of this article, is a good construction and costs about the same as the concrete cubes, but the writer can state from personal experience that the objections mentioned are very real objections, and while at present it seems to be the most popular style of construction for the main country roads, it has not the possibilities of Mr. McClintock's idea.

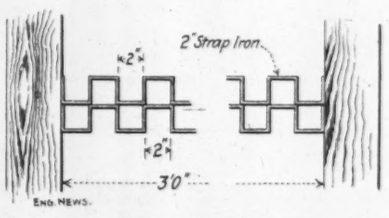

Fig. 5. Sketch of Floor Molds for Concrete Paving Cubes.

It has been suggested that the cubes be grouted or oiled and that a sunken curb be placed at the sides in place of a gravel shoulder, but short pieces of road treated in this way have proved that nothing is gained and that the cost is increased. Any unnecessary increase of even $100 per mile means a tremendous increase for a large system of roads, and for this reason it seems good engineering to stick to the cheapest construction that will give satisfactory results.

FIG. 4. ASH-CLAY CUBES AS THEY COME FROM THE MOLDING MACHINE IN HOLLOW SQUARES OF 12 CUBES EACH.
(The cubes in each square can be readily separated after burning.)

Regulation of the Level of Lake Erie.*

The organic act creating the Commission prescribed as one of its duties that it should "report upon the advisability of locating a dam at the outlet of Lake Erie, with a view to determining whether such dam will benefit navigation." It so happens that the term "dam" may apply to various works of which the character and object are very different.

At the time of passing the act, Congress had before it the report of the Board of Engineers upon deep waterways between the Great Lakes and Atlantic tide waters, dated June 30, 1900, in which it was recommended that the level of Lake Erie be "regulated"—that is, that its oscillations be reduced—by means of a submerged weir in connection with a set of sluice gates placed at its outlet near the head of Niagara River. It seemed probable that this was the kind of works which Congress had in mind when using the term "dam." Their object would be to raise the low-water surface of the lake without raising the high-water surface.

But the term "dam" may also be applied to a submerged weir without sluice gates, the object of which would be simply to raise the level of the lake without reducing its oscillations. The low-water surface would be raised, but so would the high water to nearly an equal amount. To distinguish works of this kind from those designed to "regulate" the lake, they may be called "compensating" works.

It was evident to the Commission that to make a complete study of the regulation of Lake Erie, it was necessary to make an hydraulic analysis of the general regulation of all the Great Lakes. This work was begun soon after the organization of the Commission in 1905, and was not completed until last year. The conclusions then reached from these studies were that only a very moderate degree of improvement in regulation over what nature provides is practicable in any of the lakes, and that, such as it is, this improvement is obtained at the expense and to the injury of the navigable channels below.

In the case of Lake Erie, it would be possible to raise the extreme low stages about 1 ft., and this, in turn, would raise the low-water stages of Lake St. Clair about 0.61 ft., and of Lake Huron-Michigan about 0.27 ft., all without appreciable increase in the extreme high stage. But in doing this the low-water stage of Lake Ontario would be lowered about 4½ ins., the available depth in the St. Lawrence canals would be diminished about 7.66 ins., and the city of Buffalo would suffer by increased damage from floods and from a postponement of the date of opening navigation in the spring.

The question of damages to vested rights was thus introduced in a particularly intricate form. While the advantages of regulation might outweigh the disadvantages if the persons who were to benefit from the former were identical with those who were to suffer from the latter, the difference was not great enough to justify the two governments in entering upon the vexatious question of damages. The Commission therefore decided to recommend that the "regulation" of Lake Erie be not undertaken.

*From the Annual Report of the International Waterways Commission.

There remained to be considered the other kind of works covered by the term "dam," or compensating works. The Niagara River at its extreme upper end is an important safety valve for the protection of Buffalo from the effects of storms upon Lake Erie, and should not be obstructed by a dam; but it is believed that somewhere in the river between Lake Erie and the Falls a submerged dam may be placed which will greatly benefit the navigation of the waters above without injury to those below, and with only minor damages, if any, to the adjoining lands. Without any attempt to "regulate" Lake Erie, the general level of the lake may be raised sufficiently to compensate for the damages heretofore inflicted by the Chicago Drainage Canal and other deteriorating influences.

To determine the best site for such a dam, it was necessary to make additional surveys. These were begun in July, 1909, but during the following winter it became evident that it would require many months to complete the maps and the studies required for a report. The commission therefore decided to submit to the two governments without further delay the data which it had collected and the conclusions which it had reached concerning one branch of the subject committed to it, i. e., the "regulation" of Lake Erie. This it did in its report dated Jan. 8, 1910.

The report was forwarded to Congress by the President, and was published as House Document No. 779, Sixty-first Congress, second session. An edition was printed also for the use of the Commission. It is the intention of the Commission to submit a supplementary report to cover the subject of compensating works as soon as the necessary surveys and studies are completed. The field work of the survey and more than half of the work of constructing the maps have been completed.

A NOVELTY IN BRIDGE CONSTRUCTION is demanded by a bill introduced in the Oklahoma legislature and referred to as follows by "The Daily Oklahoman:"

Knight and Rexroat are the authors of a bill requiring all railroads to rebuild wooden or partly wooden bridges of steel or concrete, or both, within 15 months. The bill also requires all railroad bridges to be fitted with steel side plates, at least 6 ft. high, an inch thick and of solid metal.

A Derrick with Inclined Mast Supported by a Cruciform Sub-Surface Foundation.

By ERIC SWENSSON.*

A little over a year ago the writer was called upon to design a derrick with a capacity of ten tons, and a boom from 65 to 70 ft. long. Ordinarily this would have been an easy task, but additional conditions imposed made the matter a little difficult. The derrick was for the purpose of handling structural stock material, and all the available yard space was to be utilized. Consequently a derrick was wanted which could describe a full circle with the boom in any position and take up in itself the least possible space.

On looking into the matter and considering all the derrick constructions I knew of, such as common stiff-leg derricks, guy derricks, etc., I was still dissatisfied. After some cogitation and study, it was decided to make it a stiff-leg derrick, but to make the stiff legs of reinforced concrete and bury them in the ground where they would cause no obstruction or trouble. This is really what the construction shown in the accompanying illustrations amounts to—stiff legs buried in the ground. Calculations showed that the scheme was practicable. The general appearance of the derrick is shown in Figs. 1 and 2.

This derrick construction is also well adapted for use on scows. It is only necesary to stick the lower part of the mast through the deck down to the bottom of the hull, and to provide the necessary framing below deck, which can easily be

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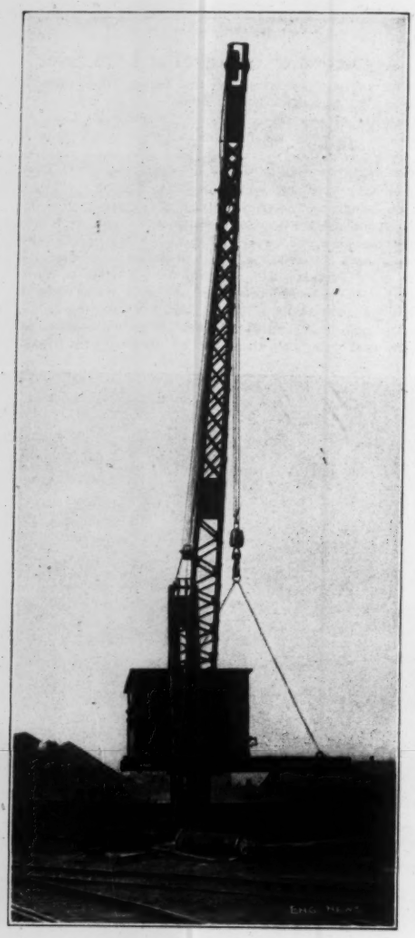

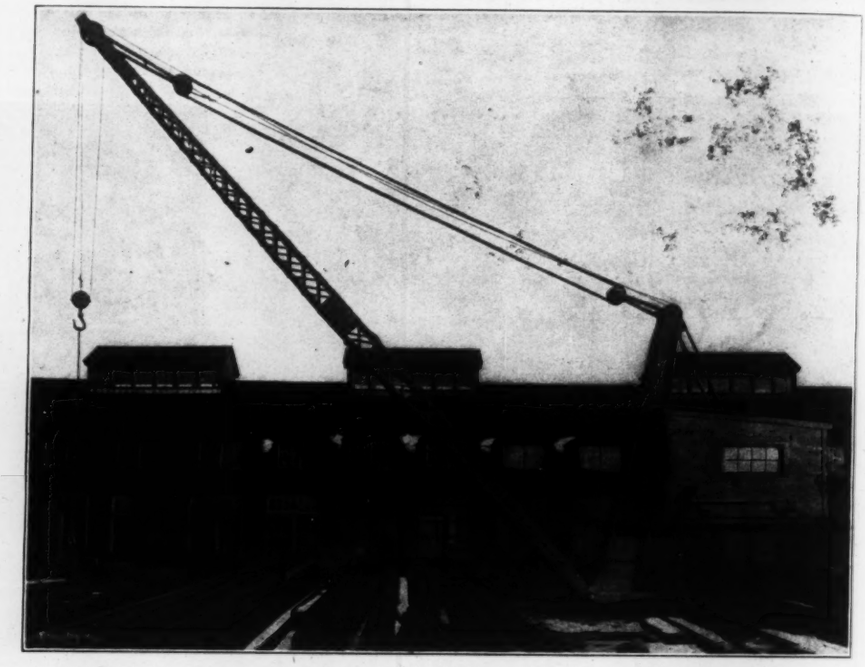

FIGS. 1 AND 2. A NEW TYPE OF DERRICK IN THE STORAGE YARD OF THE NATIONAL IRON CO., AT WEST DULUTH, MINN.
(Designed by Eric Swensson.)

FIG. 3. CLOSER VIEW OF SWENSSON DERRICK; SHOWING CONTROL CABIN AND MAST GEARING.

done. The cost of the derrick was close to that of an ordinary stiff-leg derrick of 270° swing.

MAST.—In the first place it was necessary in a derrick of this kind, without guy lines or overhead stiff legs, to bring the stresses resulting from the overturning moment of the load, directly down through the mast to the foundation. In other words, the bending moment which the mast would have to withstand would be $P \times L$, where P is the load and L is the length of the boom, neglecting dead loads. Making a mast of the section shown in Fig. 4, this purpose was easily accomplished. It will be noted that the mast is inclined backwards. One might naturally think that this was done solely to gain counterweight, but that was not the main reason. This counterweight gained is comparatively insignificant in effect with full load and horizontal boom, and the foundation is able to take care of all stresses, even without this counterweight. But still, it helps and is so much gained on the side of safety. The main reason why the mast was made to lean backward was to make it possible for the boom to stand up vertically as shown in Fig. 1. With this construction, material can be piled close to the main gear at the foot of the mast and the only yard space taken up by the derrick and not utilized for storage is the 10-ft. circle of the gear.

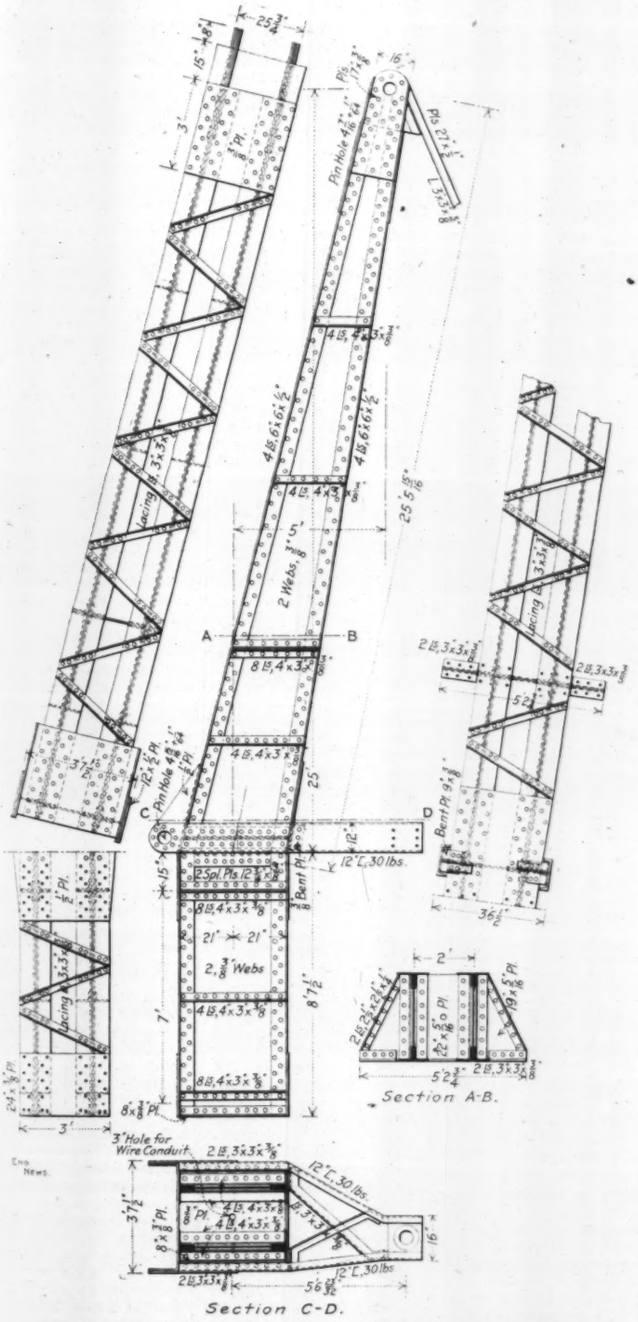

FIG. 4. DETAILS OF INCLINED MAST OF THE SWENSSON DERRICK.

FOUNDATION.—The next thing to be done was to provide a foundation able to resist the stresses resulting from the overturning moment under full load, with boom horizontal. Naturally, mere weight would accomplish this purpose, but it is easily seen that a cruciform reinforced-concrete foundation, as shown in Fig. 6, meets the requirements better and more cheaply. Knowing the bearing capacity of the soil, the length and strength of the reinforced-concrete arms are easily calculated. In addition, the concrete wall of the pit wherein the mast sits, has to be suitably reinforced by circular rods as shown. If there is any error there, it is on the side of safety. There was no need of any cheese-paring economy, as a very few dollars would go a long way for strength and safety.

MAST BEARINGS AND PIT.—Being safe about the mast and foundation, it was necessary to investigate the frictional resistance against turning. I have been asked innumerable times this question, "You have of course roller bearings there?" meaning the bearings on the lower part of the mast in the pit, which bearings provide the two necessary forces to counteract the overturning moment of the load. In reply I have to say that so far as calculations and actual experience go, there is no need of roller bearings. Roller bearings are expensive and to be avoided where not needed. The secret of the matter is simply this: While the friction resistance in the construction shown, with horizontal boom and full load, is very considerable, yet the slow turning speed required in a derrick (say one revolution in two minutes) calls for a very moderate amount of horsepower. It is only a question of providing the proper gearing.

The castings for the bearings on the foot of the mast and in the pit are shown in Fig. 5. It will be seen that the gearing at the top of the pit is 5½-in. pitch. The rest of the gearing above (see Fig. 3) is in proportion. For the reason that the company which ordered this derrick does not make steel castings, cast-iron was used all through the construction. With steel castings, the sizes shown could be reduced.

While considering this matter of turning the derrick, it should be mentioned that originally the gearing was calculated for a turning speed of one revolution in two minutes. But Mr. Walter Evered, the purchaser of the derrick, is a great fellow for using old patterns, and therefore the gearing was slightly changed in order to use the patterns which he had in stock. Consequently, actual timing shows that the contemplated speed of one revolution in two minutes was changed to one revolution in one and a quarter minutes, which I think is faster than needed. No special trouble, however, has resulted from this change.

MOTIVE POWER.—Referring to the machinery part of the derrick, it will be seen that we used a 25-HP., three-phase motor, 25 cycles, 470 r. p. m., 440 volts. Current was obtained from a switchboard in a nearby building and was taken in underground trenches through the usual conduits to the bottom pivot casting shown in Fig. 5. The holes provided for the wire conduits are shown in the drawing. In the center of that portion of the mast which is in the pit, a three-phase brush connection was arranged so that no matter how the derrick turns no wires will be tangled up.

While naturally an electric hoist, one of the many that are on the market, would be the most suitable for running a derrick of this kind, yet, owing to exigencies in this case, we remodeled for the purpose an old 8x10-in. hoisting engine which Mr. Evered had in stock. The motor and the controller were put in place of the boiler. The cylinders, of course, were removed. The controlling levers, five in all, excluding the dog handles, were removed to a stand near the controller, but the rest of the 8x10 machine was utilized, that is, the main frame and the drums. The drums were 12 ins. and 16 ins. in diameter.

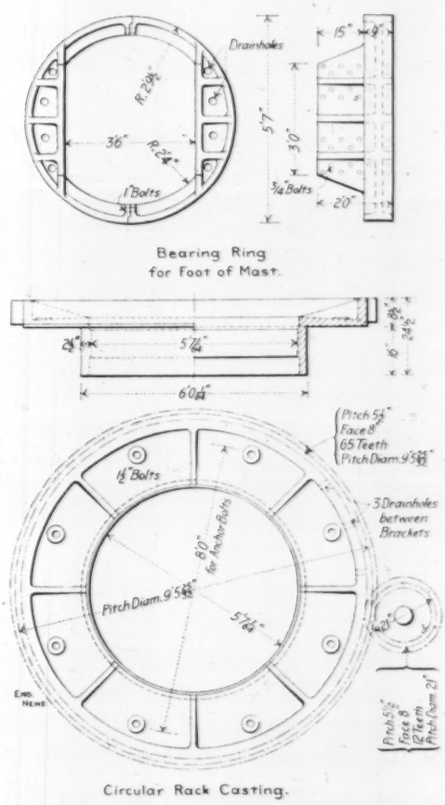

Fig. 5. Castings for Bearings on Foot of Mast.

For turning the derrick, a friction clutch attachment was put on the front drum. This clutch works a bevel gear which acts through spur-gearing just below the machinery floor to actuate the main pinion on top of the foundation. This is not an ideal arrangement, but nevertheless it has worked so far and given no trouble. Ordinarily in designing a derrick of this kind, I would specify an electric hoist of suitable power and qualities.

The Opportunity for Engineers in Highway Work.*

By A. N. JOHNSON,† M. Am. Soc. C. E.

Up to a few years ago, highway construction and location received scant attention from engineers. There was apparently little interest taken in the improvement of rural roads anywhere in the country until about 1890, when the wide use of the bicycle called attention to the condition of the roads.

In 1893, the first course offered in highway engineering in this country was opened, at Harvard University. Lectures were given by Mr. W. E. McClintock, Chairman of the Massachusetts Highway Commission. By 1905, 11 of the 15 principal engineering schools in the country gave courses in highway engineering, although the time devoted to such courses averaged but 32 hours. In the past few years a number of schools have greatly enlarged this work.

At about the same time that the states turned their attention to road improvement, the U. S. Government appointed a Bureau of Inquiry on the subject. Unfortunately for the first few years of the history of this branch of the government service, it was not conducted on a plane that could command the respect of scientifically trained men, and it has been only within the past few years that the Bureau has been conducted in a manner to make it an aid to engineers.

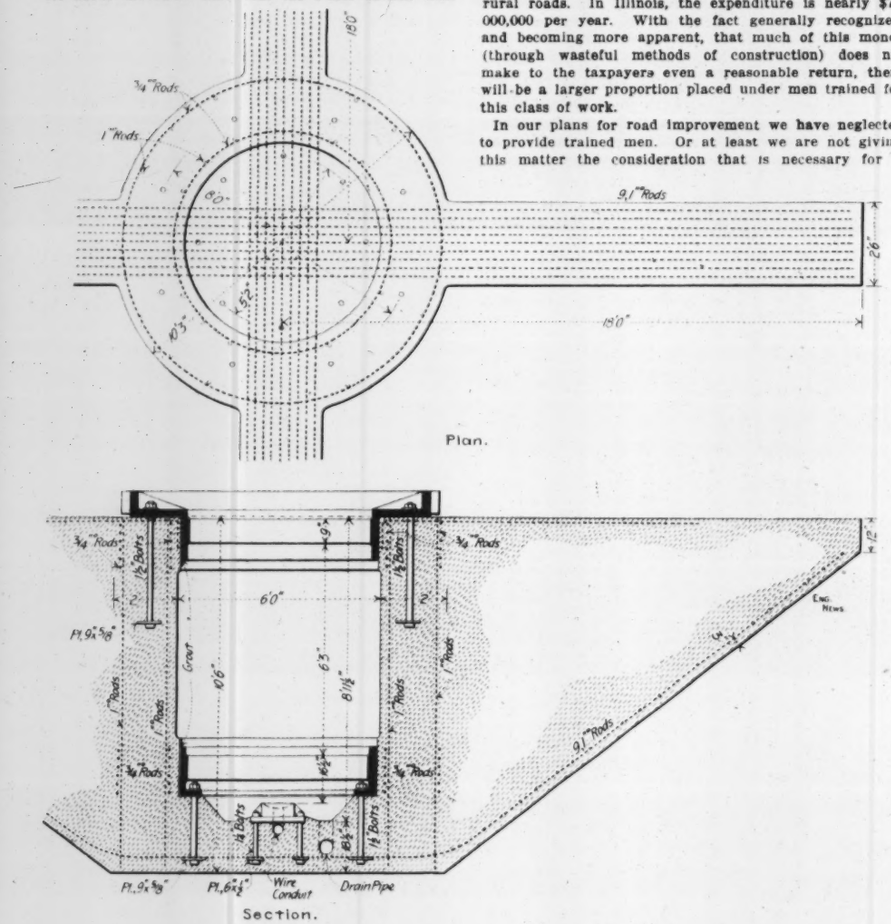

FIG. 6. FOUNDATIONS AND MAST PIT OF SWENSSON DERRICK.

We are on the eve of a renewed interest in highways, due to the development of the automobile. A few years ago, if the roads for eight or ten miles from a city were in good condition, they satisfied the needs of the locality. To-day the automobile demands stretches of road from 100 to 200 miles in length, and the construction of these long stretches of road is actually under way. In Massachusetts, the roads have been gradually connected so that practically all sections of the state can now be traversed over these improved roads. New York is building roads throughout the Adirondacks for little other purpose than to accommodate this class of traffic. Connecticut and New Jersey have constructed lines of roads, but this work is only in its infancy.

Since 1893, 24 states have made appropriations for road work to be done under engineering supervision. The total amount appropriated up to 1909 was about $56,000,000. In general, an equal amount has been added by the local communities, so that the total amount of road work done is not less than $112,000,000. Practically all of this has been spent under engineering supervision, and 60% of the amount has been spent within the past six or seven years.

Some of the counties of California are appropriating more than many states. Within the past two or three years, for example, Los Angeles County appropriated $3,000,000; San Bernardino County, $2,000,000; San Diego County, $3,000,000. Each of these counties secured engineers who had been trained in highway work elsewhere.

In addition to these expenditures for work under the direction of highway engineers, there remains a much greater amount spent annually (on roads and bridges) which is not spent under men with technical training. Statistics gathered by the U. S. Office of Public Roads show that a total of $80,000,000 a year is spent on our rural roads. In Illinois, the expenditure is nearly $7,000,000 per year. With the fact generally recognized, and becoming more apparent, that much of this money (through wasteful methods of construction) does not make to the taxpayers even a reasonable return, there will be a larger proportion placed under men trained for this class of work.

In our plans for road improvement we have neglected to provide trained men. Or at least we are not giving this matter the consideration that is necessary for a well balanced development. While there are in this country roads as well constructed as those abroad, and by equally scientific methods, our systems of maintenance are far behind. Proper maintenance means work planned and laid out on scientific basis, necessarily involving the steady employment of trained men.

In many states, the expenditure on highway bridges is not far from half the total amount spent by the rural taxpayers on roads and bridges. In Illinois, there is expended over $3,000,000 per year on bridges. In but few instances have bridges been erected under the advice of an engineer retained by the local officials. The bridges have been designed almost exclusively by the companies building them, and it is no unusual experience to see such structures replaced in the course of eight or ten years.

The State Highway Commission of Illinois was, I believe, the first state commission to give specific attention to highway bridge construction. There was offered to the local officials (without cost) assistance in the design, estimating and supervision of erection of highway bridges. The result is a marked change in the character of highway bridges. Concrete bridges were introduced where formerly light steel structures had been built simply because the local officials had no knowledge as to the proper structure to erect. This work has been taken up by Iowa, Wisconsin, Minnesota and other states.

*Abstract of an address delivered before the American Good Roads Congress (Indianapolis, Dec. 6) and the American Association for the Advancement of Science (St. Paul, Dec. 27).

†State Highway Engineer, Springfield, Ill.

Levee and Drainage Project at East St. Louis, Ill.*

By. T. N. JACOB.†

The East Side Levee and Sanitary District of East St. Louis, Ill., has an area of 96.36 sq. mi., all being in the bottom ground and forming a part of the "American Bottom." The district extends from Prairie du Pont Creek north to two miles above Mitchell, a distance of 18 miles. In general it is bounded by the Mississippi River and the Illinois bluffs, making an average width of seven miles. The district has a population of 100,000 and a property value of about $100,000,000. It includes the cities of East St. Louis, Granite City, Madison and Venice; also the villages of Cahokia, National City, Brooklyn, Nameoki and Mitchell. There are 17 trunk railways, two coal roads and four traction lines; also many large factories and packing houses.

The district being lower than the flood plane of the Mississippi, requires the construction of defenses to keep out the flood waters. The condition is aggravated by flood from the smaller streams extending from the hills to the river. The most important of these streams is Cahokia Creek. Its catchment area in the hills is 275 sq. mi. The smaller tributaries add 66 sq. mi., making a total of 325 sq. mi. of hill drainage. To this add 57 sq. mi. of bottom land, making the total catchment area of Cahokia Creek, 382 sq. mi. The balance of the smaller streams that discharge into Prairie du Pont Creek have a total catchment area in the hills of 24 sq. mi. and in the bottom 41 sq. mi. The grand total catchment area tributary to the district is 447 sq. mi.

In earlier days many small levee and drainage districts were formed. Because of limited funds, the ditches and levees were not of sufficient dimensions to withstand the higher floods and to drain off surface waters with sufficient velocity to prevent the ditches from filling up. When the railways were constructed their embankments served as levees. The rapid industrial development of the district made it necessary to put all reclamation matters under one management, and this has brought about the formation of the East Side Levee and Sanitary District. The Board of Trustees was elected Dec. 16, 1908.

Surveys were started in April, 1909, and a topographic survey, covering 127.5 sq. mi. was completed before cold weather. The cost of the field work, including supervision and transportation, was about 16 cts. per acre. The method adopted was that of control lines measured with steel tape; check measurements were made on all control lines. The topography was taken by the stadia method, each transit man being assisted by a recorder with sketch book. The geographic position of each transit point was determined by office calculations and the maps were plotted from meridians and parallels, a high degree of accuracy being obtained. All lines of levels were carefully checked and no error exists greater than 0.10 ft. The map is plotted in sheets 4 × 4 ft. on a scale of 1:5000. All improvements and topographic features are shown, including contours at 2-ft. intervals.

For improving the sanitary conditions, the plan is to provide a system of canals to control the discharge of water falling in the catchment area tributary to the district (and thus prevent the overflowing of the smaller streams), and to drain off the water that accumulates and becomes stagnant in low areas; also to provide a system of levees that will prevent overflows from the river.

Cahokia Creek being the most important of these streams, will have the first attention. The stream follows a very tortuous route along the district for a meander distance of about 30 miles (the lower three miles being through the railway yards in East St. Louis), and finally empties into the Mississippi River at Pittsburg Dyke. Its flood waters overflow an area of about 45 sq. mi. to a depth of 3 to 5 ft. During high stages of the Mississippi River, the creek permits back water to enter the district and overflow large areas.

As there are many reasons for not attempting to confine the creek to its present channel by means of levees, it was decided to divert the major volume of its waters to the river by a new channel about 4½ miles long. This channel is 100 ft. wide on the bottom, with side slopes of 2 on 1. It is provided with a low-water channel 30 ft. wide and 2 ft. deep, to confine the water at low stages to a smaller area for the purpose of preventing the deposit of sediment. The channel is spanned by nine bridges carrying four highways, four steam railways and one electric line. The levees on either side are made with material excavated from the channel. The crown of the river front levee will have an elevation equal to a gage height in the river of 45 ft. The flood of 1903 reached a gage height of 38 ft.; the highest flood of which there is authentic record (1844) reached a gage height of 42.3 ft. This levee

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, at East St. Louis, Ill., Jan. 25-27. A note of the project (with map) was given in our issue of Nov. 28, 1907; also in our issue of Feb. 4, 1904.

†Chief Engineer, East Side Levee and Sanitary District, East St. Louis, Ill.

will be of the following dimensions: crown, 8 ft.; front slope, 2 on 1; rear slope, 3 on 1; berme, 40 ft. The front slope will be paved with 5-in. concrete.

The drainage of the entire district will be done by a system of canals, main and lateral. The diversion channel will take care of the main volume of water from the hills. The main drainage canal will tap the old channel of Cahokia Creek and run southwest through the lakes and low ground to Prairie du Pont Creek. This canal will have a bottom width of 80 ft., with a grade of 1 ft. per mile. It will be deep enough to reverse the flow of the creek, drain the lakes (except Horseshoe Lake), and low ground, and receive the water from the hills, tributary to the district south of the diversion channel. Horseshoe Lake is too deep to drain by this method, but will serve a valuable purpose as a storage reservoir during periods of excessive rains.

Where the drainage canal enters Prairie du Pont Creek (at the south levee), controlling works, consisting of flood gates and pumps, will be installed. The flood gates will be closed during very high stages of the Mississippi River, and the water in the canal will be discharged into the river by centrifugal pumps. As soon as the diversion channel is in service, a temporary closure of the mouth of Cahokia Creek will be made, and a flood gate and pump will be installed to take care of the waters discharged by the creek until the drainage canal is completed. Then this gate and pump will be removed and the present mouth of the creek closed permanently. The estimated cost for the improvement outlined is $6,500,000.

The contract for the Cahokia Creek diversion channel was let May 21, 1910, to the S. R. H. Robinson & Son Contracting Co., to be completed in one year. The work includes 1,500,000 cu. yds. of channel excavation and levee construction, one 30-in. and one 24-in. iron pipe culvert, and one reinforced-concrete box culvert 4 × 5 ft.; all equipped with self-acting flap valves at the outlet and hand-power gates at the intake. The contractor's plant consists of a 70-ton steam shovel with 2½-yd. dipper, 3 16-ton locomotives, 54 4-yd. dump cars, 6 drag-line excavators with 1½ and 2½-yd. buckets, 20 teams with plows, scrapers, etc.

Bids have been received for four highway bridges, to be completed by May 15. The railway bridges and track elevation work will soon be ready for bidders. All of the work in connection with the diversion channel will be completed next summer. It is expected that complete river protection will be completed in three years. With protection from floods of Cahokia Creek and the river, the matter of interior drainage will be taken up and the stagnant water that is now confined in low areas, will be removed by permanent drains, completing the sanitary work that is very much needed, and reclaiming large areas of land now of little value.

A Multiple-Spool Hoist for Foundation Work.

A hoisting apparatus for handling eight ropes or cables quite independently of each other is an interesting machine which has been designed to meet special conditions in the construction of foundations at Chicago.

The increasing development in high and heavy buildings and the increasing disturbance of the clay bed underlying the city by tunnels and other works has necessitated the introduction of deep foundations to obtain a solid footing or support upon rock or hardpan beneath this deep bed of clay. The almost universal method is to sink wells (4 to 12 ft. diameter) to the hard stratum (at depths of 60 to 110 ft.) and to fill these with concrete to form foundation piers. This system of construction has been described in our columns at different times.*. The wells are sunk in open excavation, being lined with tongued-and-grooved planks (usually in 3 ft. lengths) braced on the inside by steel half-hoops put together to form circular braces.

As a rule, several wells are being sunk at the same time, and means must be provided for the operation of the bucket hoists by power. Where the work is done in the open, as on a new site or where the old buildings have been removed, a method very generally employed is to locate a hoisting engine at one end of a row of wells, this engine operating an endless cable which extends the full length of the row and is running continuously. At each well, the cable passes over a friction sheave connected by a clutch to a winch or nigger-head. The bucket rope is passed over a pulley block suspended over the well by a tripod, and is then led around the winch head, the end of the rope being held by a man stationed at the top of the well. To hoist the bucket, the man pulls the coils of the rope tight upon the revolving winch, so that the friction is sufficient to raise the load. To lower, he slacks the coils and allows the weight of the bucket to overhaul the rope. If the wells are not in exact line, the cable must be deflected by guide sheaves.

This method has the objection that any failure of the running cable will put all the winch heads out of use, and may result in dropping the buckets down the wells. Furthermore, the plant must remain in place until the last well is finished, the hoisting rigs of the wells first completed being idle. The running cable may also form an obstruction to work at the surface, but in some cases this is avoided by putting the winches on working platforms at a sufficient height to leave the surface clear. This also enables the muck to be dumped into wagons driven under the platforms.

The running-cable system cannot be used, however, where the site is obstructed. In many cases where old structures are to be rebuilt, the foundations for the new structure are put in before the old building is removed, thus avoiding a long and serious interruption to business. In other cases, buildings having originally shallow foundations have had deep foundations put under them in consequence of the disturbance of the clay bed by tunnels and other construction works which drain the water and may lead to settlement. Numerous cases of this latter kind will be necessary when the construction of the proposed street railway subway is undertaken. In both such cases the basement is usually vacated for the foundation work, and the columns of the building are supported temporarily by jacks and blocking in the basement. Under these conditions the available space is so limited and obstructed that it would be impossible to locate a running cable to serve a number of wells in the manner described above. In some work of this kind individual electric motors have been installed, each operating one or two wells.

To meet these unusual conditions a special type of hoisting machine has been designed, which can operate buckets in eight wells, with an independent cable for each well. The cables can be run in practically any direction, four on each side of the machine. A general view of one of the machines is shown in Fig. 1. A 20-HP. motor at one end of the frame is belted to the main shaft, which drives the eight spools through gearing and clutches. It will be understood that the rope is not wound upon and payed out from a drum (as in a hoisting engine), but is merely passed around the spool. In the event of any rope coming off a pulley or spool, it does not interfere with the work of any of the other ropes. As soon as one well is completed, also, the cable can be shifted to a new position without regard to the condition of work in any of the other seven wells.

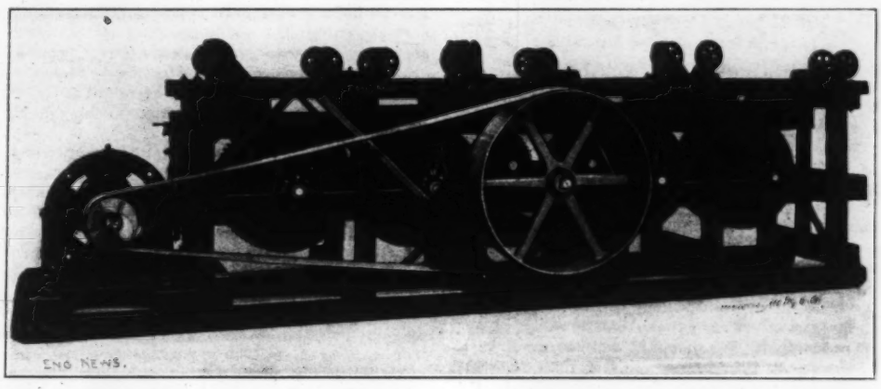

FIG. 1. AN EIGHT-SPOOL HOIST OPERATING EIGHT CABLES INDEPENDENTLY.
(The Thomas Elevator Co., Chicago; Builders.)

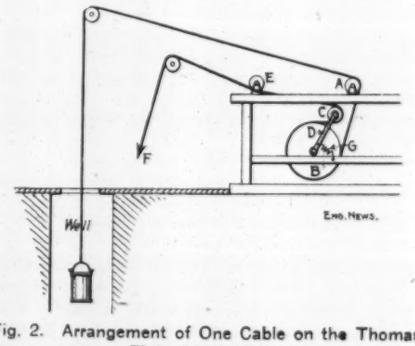

Fig. 2. Arrangement of One Cable on the Thomas Eight-Spool Hoist.

The arrangement is shown clearly by the sketch, Fig. 2. From the bucket the cable is led to a pulley block suspended over the well by a frame or attached to overhead timbers; it passes then to a guide sheave (A) on the frame of the machine, which sheave can be set at any angle, according to the position of the well in relation to the machine. The rope is then led around the grooved spool (B) and around a pulley (C) on the clutch lever (D); its free end then passes under the guide sheave (E) and runs to the well, where it is held by the man in charge of raising and lowering the bucket, at (F). A spring (G) holds the clutch lever normally in the released position, the spool being then free to revolve and let the rope overhaul by the weight of the bucket. This movement is controlled by the man at (F) slackening or tightening the rope as it leaves his hands. To hoist the bucket, the man pulls on the rope so as to pull over the clutch lever and thus throw the spool in gear with its friction drive. At the same time he hauls in the free end of the rope, as if he was hoisting by hand, but of course exerts only power enough to hold the clutch lever over. The rope does not slip in the spool, but the spool slips on the friction disc, which serves both for driving and braking.

Two of these eight-spool hoists are in use for the sinking of foundation wells under the dry goods store of Mandel Brothers, Chicago, which building (at the corner of State and Madison Sts.) is to be replaced by a new and heavier structure. This building will be about 150 × 190 ft., with 16 stories and three basements. The new foundations will consist of 61 concrete piers from 8 to 11 ft. diameter, in wells sunk to rock at a depth of about 110 ft. The general contractors are John Griffiths & Son. The hoists were designed and built by the Thomas Elevator Co., of Chicago.

*Engineering News, Dec. 22, 1904; Oct. 12, 1905.

TRIPLE-EXPANSION LOCOMOTIVES and condensing locomotives have been suggested at various times, and have obtained public notice recently. The condensing locomotive came to light in the daily press in a reporter's account of a train being stopped near Chicago by the engine drawing up fish from a track tank. It was stated that on removing "the piston of the condenser" the latter was found to be packed with fish.

Of more serious interest is the triple-expansion locomotive, which has recently been patented by Mr. S. M. Vauclain, of the Baldwin Locomotive Works. His design provides for an elongated locomotive of the Mallet type, having three (instead of two) groups of drivers. These groups are driven by cylinders using high-pressure, intermediate and low-pressure steam, respectively.

The Presidents of Four National Engineering Societies.

(With inset sheet of portraits.)

In accordance with our annual custom, continued now for eighteen years, we present to our readers with this issue, portraits of the Presidents of four National engineering societies, with biographies of the professional career of each. On account of the reelection of Mr. D. W. Brunton to the Presidency of the American Institute of Mining Engineers, we have substituted for that society this year the American Railway Engineering and Maintenance of Way Association. Mr. Brunton's photograph and biography appeared in our issue of Jan. 21, 1910.

Mordecai T. Endicott, President of the Society of Civil Engineers

By A. C. CUNNINGHAM,* M. Am. Soc. C. E.

The selection of Mordecai Thomas Endicott for the presidency of the American Society of Civil Engineers is a deserved recognition of a prominent engineer, and as well of the United States Navy and the Corps of Civil Engineers of the Navy. The profession has no more accomplished or worthy member, the navy no technical officer of greater faithfulness and patriotism, and the Corps no member on whom it can better model its professional and personal conduct.

Mr. Endicott was born in May's Landing, in 1844, being a direct descendant of John Endicott, the first Colonial Governor of Massachusetts. He was graduated from the Rensselaer Polytechnic Institute of Troy, N. Y., in 1868, with the degree of Civil Engineer. For four years he practiced his profession in civil life, and in 1872 became a civil engineer in the navy. During the next eighteen years Mr. Endicott performed civil engineering duties in the important navy yards on the Atlantic coast, becoming familiar with naval conditions and requirements, and establishing a reputation for reliability, thoroughness and originality. His success in navy-yard work resulted in his detail, in 1890, to the Bureau of Yards and Docks, Navy Department, as Consulting Engineer in charge of civil engineering work. This detail he held until his appointment as Chief of Bureau. During this period he designed the first dry dock for the Puget Sound Navy Yard, improving on the then standard timber constructions by providing a concrete and stone entrance.

One of the problems confronting the Navy Department at this time was the placing of armor plate on the new battleships under construction, work which might have to be done in the navy yards. For this purpose he designed the 40-ton gross capacity, locomotive jib cranes, which have since retained the standard for work around dry docks.

Mr. Endicott came into national prominence in 1895, when President Cleveland appointed him a member of the first Nicaragua Canal Commission, the other two members being Col. Wm. L. Ludlow, of the Corps of Engineers and Mr. Alfred Noble. The report of that Board was a determining factor in fixing the policy of the United States with respect to the Isthmian Canal project.

Mr. Endicott was also made a member about this time of the United States Armor Factory Board, which was created by Congress.

On the eve of the Spanish War the position of Chief of Bureau of Yards and Docks, Navy Department, became vacant. It was a serious situation as the new Chief was practically certain to carry this bureau and the responsibility for public works in the navy through a period of war. Not being a purely military bureau, its Chief would be practically thrown on his own resources. The Secretary of the Navy, Mr. John D. Long, with his usual splendid judgment, selected Mr. Endicott for this task. He knew the character of the man and had observed his capacity for work. A precedent of 74 years was broken in this appointment which before had always been given to an officer of the line. It was also necessary to increase Mr. Endicott's rank from Commander to Captain to comply with legal requirements, and this was done by action of the President.

Only those who were with Mr. Endicott during this war period can appreciate the task that was given him to do, and many pages can be summed up in saying that he did it—successfully and well. His chief clerk, an important factor in any Bureau, was soon prostrated by the pressure of work; two old and important clerks were nearly incapacitated by the rush of their duties, throwing a vast amount of detail on the Chief in connection with his engineering duty. Few could have stood up even under the pressure alone, not to mention the responsibility. The success of Mr. Endicott's first four years' administration is best shown by his unopposed and generally approved appointment to a second term. The approval of his entire administration is shown by his third appointment, so that he might go on the retired list with the rank carried by his bureau, that of Rear Admiral.

A few of the important things accomplished by Mr. Endicott during his administration of the Bureau of Yards and Docks should be mentioned. He inherited a corps of ten commissioned civil engineers. So much energy and progress was put into the public works of the navy that on his recommendation and the approval of the Navy Department, the corps was increased to 40 members. The standing of the corps was raised by requiring thorough entrance examinations. The entrance of naval academy graduates in the corps, after a special engineering education, was encouraged and inaugurated. The work accomplished by Mr. Endicott and his corps of civil engineers finally resulted in Congressional action limiting the appointment of a Chief of Bureau of Yards and Docks to an officer of the Corps of Civil Engineers of the navy.

Mr. Endicott has had direct charge and responsibility of the designing of eleven dry docks for the navy. Three of the first were required by Congress to be of the timber standard. By his personal work, practically unaided, and against great outside opposition, he convinced Congress of the soundness of his stand, and secured the change of these timber docks to concrete and stone construction, and set up a new dry-dock standard for the navy. Two of his docks were of the floating type, the first large steel floating docks to be used in the navy or in the United States. The first floating dock, that for New Orleans, was an English design, but much improved and strengthened by the Chief. Its success led Congress voluntarily to provide the "Dewey" for the Philippines. From his experience with the first floating dock, the Chief specified a structure for the second that far surpassed anything of its time, and the contract was made on a new American design. On the completion of this dock his personal influence was an important factor in securing its towing to the Philippines by the navy. Mr. Endicott is clearly the father of floating steel dry docks in the United States Navy.

Mr. Endicott also secured, first the consolidation and centralization of power plants in navy yards, and then the electrical pumping of dry docks from a central station. He was the first practical and active advocate here of logical "consolidations." He made the specification which secured the new type of floating crane for the navy, consisting of a fixed horizontal trolley with great height and long reach and an automatic counter-weight which always keeps the crane level. This has become a standard for navy-yard work in handling guns, turrets, boilers, and other heavy objects, and the capacity is increasing beyond the 100 gross tons started with.

He has always been vigilant in protecting the Government's interests, and this has shown in a marked degree in the acquirement of land for naval uses. In one instance on a tract of about three hundred acres he twice rejected the estimates submitted by local commissions, and finally secured a much more favorable price direct from the local owners of the property.

During his second administration of the Bureau, Mr. Endicott was selected by President Roosevelt as the naval representative on the Panama Canal Commission. Whether the canal was to be of the lock or sea-level type was to be determined at this period. An International Commission on the question voted for a sea-level canal, the majority of eight in thirteen containing five distinguished foreign engineers. On the Panama Canal Commission itself, Mr. Endicott was the only commissioner who voted for a sea-level type.

The Chief was looking beyond his own time to a period when it might be desirable both to deepen and widen the canal, to pass a fleet of war vessels most quickly. He was looking to the absolute safety and preservation of this great work in an earthquake country. His vote in this matter was given at a time when it required more than the courage of one's convictions to differ with the administration. He felt that he was a trustee of the nation's good and never for an instant considered his own interests.

The law gives Mr. Endicott the rank of Rear Admiral, but confines his official title to Civil Engineer. The President, Members of Congress and most naval officers have, however, taken pleasure in addressing him by the honorary title of his rank.

Admiral Endicott has been a torch bearer in the navy in the line of his work and duty, and, as time lengthens the perspective, the height of his achievement will become more and more apparent.

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Edward Daniel Meier, President of the American Society of Mechanical Engineers.

By H. L. ALDRICH* and WM. H. BOEHM.†

Edward Daniel Meier, the recently elected president of The American Society of Mechanical Engineers, is typical of the man who makes the most of inherited talents. On his father's side are generations of merchants and lawyers in Bremen, Germany, and on his mother's side are mariners and men of mechanical and engineering ability. He was born in St. Louis, Mo., May 30, 1841, and he began his education with the country school, passed through the various higher grades and then entered Washington University, in that city, where he spent the years from 1856 to 1858. Following this he spent the years up to the summer of 1862 in the Royal Polytechnic College at Hanover, Germany.

Equipped with this engineering education he returned to the United States and started on his professional career with the then famous shops of the Mason Locomotive Works at Taunton, Mass., where he remained until 1863.

The Civil War being in its hottest stage about this time, he enlisted as a volunteer in the Union Army and remained with it until the close of the war in 1865. He was with the 32d Pennsylvania Regiment (now known as the First Pennsylvania), afterward in Nim's Second Massachusetts Battery, and saw much of the fighting in the Gettysburg and Red River campaigns, and in the defense of New Orleans. He was also engaged in service with the First Louisiana Cavalry in campaigns against guerillas in Northern Louisiana. In Southern Mississippi he was aide-de-camp on the staff of Gen. Davidson and in the closing weeks of the war received the surrender of many officers in the Confederate service.

The war over, like most others who had distinguished themselves in the army, Lieut. Meier promptly turned his attention to peaceful pursuits, and he followed them with the same earnestness and activity that had characterized his military career. But the military spirit continued active in him for in 1877 he organized the first company of emergency militia in St. Louis. This company served in railroad riots and did important duty in St. Louis and adjoining territory. He later organized a permanent military company in St. Louis. He was elected captain and afterwards when the company was increased to a battalion he was elected major. Later when the emergency companies were merged in the First Regiment of the Police Reserves he was elected lieutenant-colonel. When there was a reorganization of the state military force of Missouri he became colonel and afterwards was put in command of the entire state militia. The appointment of brigadier-general, however, was de-

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lined and soon he resigned from this service. His military experience brought him into close relations with several of the more prominent army officers of that time, especially with Gen. William Tecumseh Sherman.

At the close of the Civil War, Lieut. Meier spent a year or more as machinist and draftsman in the Rogers Locomotive Works, in Paterson, N. J., and from 1867 to 1870 he was Assistant General Superintendent and later Superintendent of Machinery for the Kansas Pacific Ry. During this period he built and operated the Junction City stone mill and designed machinery for quarrying and dressing the soft magnesian limestone found in the Kansas Valley. He designed and equipped a number of railway shops for the Kansas Pacific Ry., and was engaged in this work until his health failed in 1870. He spent the following year traveling through Europe, incidentally studying the coal-washing and coke-making industries of different countries.

Returning in 1871 he designed and perfected machinery for companies in the vicinity of St. Louis. From 1873 to 1875 he was engaged as mechanical engineer in the designing and building of machinery, and in doing various kinds of engineering work in connection with stationary steam plants. He carried out other work at this time as consulting engineer in connection with river dykes, the laying out and equipping of cotton factories, and the designing and improving of cotton presses. He designed and patented powerful hydraulic cotton-compressing machinery which was superior to anything used up to that time and which is still in successful operation.

In 1882 he began developing the well-known Heine type of water-tube boilers and from 1885 to the present time he has been President and Chief Engineer of the Heine Safety Boiler Co.

With the great increase and amount of power used for industrial and other purposes came the increase of steam pressure, and the steadily increased capacity of steam boilers. There was also the change from iron to steel in the construction of boilers, and the first official specifications drawn up by the American Boiler Manufacturers' Association were under the immediate supervision of Col. Meier. This association has always comprised the leading manufacturers of boilers of all types throughout the United States; for several years Col. Meier served as its secretary, and for some years past he has been president, and one of the most active and influential members. Whenever the question of material for boilers was under consideration, either by State or Federal authorities Col. Meier was one of the first specialists called upon for advice because of his great experience and intimate knowledge of all branches of the boiler business. To this day practically all the improvements and advancements that have been made in the past twenty years in the legal requirements of boiler material have been through the suggestions and under the advice of Col. Meier and his associates.

Like so many engineers who have been devoted to their profession, Col. Meier has gone outside of his immediate work many times to engage in the designing and perfecting of other devices. In 1877 he designed and perfected scaling ladders, and other types of life-saving apparatus for use in connection with city fire departments. Several of these inventions were adopted by St. Louis, New York and other large cities, and still form an important part of the equipment of the fire department of these cities. When the rights for the manufacture of the Diesel engine were brought to this country in 1897 he became consulting engineer for Adolphus Busch, the chief financial backer, and ever since has been connected, more or less actively, with the American development of these engines.

Very few engineers in the United States have had a more varied and more useful experience than Col. Meier. His contributions to the practice of boiler making have been especially valuable and in no way could his service be more fittingly recognized than by his recent election as the president of The American Society of Mechanical Engineers. During the 30 years of the existence of this society no man has been President who has worked more conscientiously for the upbuilding of engineering than has Col. Meier, and few have worked as successfully. His association with The American Society of Mechanical Engineers in an official capacity began in 1895, when for three years he served as one of the managers. He was Vice-President from 1898 to 1900 and from 1909 to 1910.

The social side of life has been unusually developed by Col. Meier, through a great capacity for attending to interests outside of his professional work. In St. Louis he has been a member of the University Club since 1876, of the Noon-Day Club since 1896, and he was active in the affairs of the Electric Club in the years 1894 to 1896. Naturally, on account of his interest in military affairs he has been an active member of the Grand Army of the Republic and of the Military Order of the Loyal Legion. He has also been a member of the Army and Navy Club, in New York City, since 1899. He became a member of the American Institute of Mining Engineers in 1880 and he has been identified with the Institute ever since. In 1895 he became a member of the Engineers' Club of New York City and when the Machinery Club was organized he was a charter member. He is still on the board of governors of this last club.

As a presiding officer few men are more experienced and more self-controlled than Col. Meier, or have a better command of language. Although in his seventieth year he has preserved his military carriage and an engaging manner.

Few men have been more fortunate in their family life. He has three sons and three daughters, and four grandchildren.

Dugald C. Jackson, President of The American Institute of Electrical Engineers.

By HENRY H. NORRIS,* M. Am. Inst. E. E.

The President of the American Institute of Electrical Engineers is selected not only as a recognition of his standing in the engineering profession but also because he has shown an active and effective interest in the welfare of the Institute. The position is not merely one of honor; it entails hard work on the part of the incumbent. In selecting a President the membership realizes, to some extent at least, that the progress in Institute policies depends very largely upon his initiative. The routine work is well taken care of by the salaried officers, but under the present organization it is expected that the President will propose changes in policy which may seem desirable or that he will carefully study the suggestions of others and lay them before the Board of Directors at the proper time. The President also selects the members of the numerous committees having charge of the details which compose the Institute's activities. This requires a knowledge of the characteristics of the Institute membership and an ability to select wisely the individuals who will do effective committee work. The almost unanimous election of Prof. Jackson last year was an expression of the confidence of the electrical engineers of the country in his ability in the lines of work indicated. A brief study of his career will indicate the basis of this confidence.

Prof. Jackson is in his forty-sixth year. During the period between the time of his graduation from Pennsylvania State College as a civil engineer in 1885 and the present time practically all of the commercial progress of electrical engineering has been made. He was fortunately well prepared, by training and by natural aptitude, to take advantage of the opportunities which presented themselves. He has, therefore, kept in close touch with electrical engineering progress practically since its beginning. After graduating from college he spent two years at Cornell University in graduate study and as instructor. Ithaca was, at that time, one of the few places where electrical engineering was recognized as a promising field for educated men. Prof. Wm. A. Anthony, then at the head of the Department of Physics, was greatly interested in the application of electricity to lighting and to power transmission. He had, with the assistance of Mr. Geo. S. Moler, constructed the first Gramme direct-current generator in this country. He had also installed a successful arc-lighting system on the University campus. In the spring of 1883, at the suggestion of President Andrew D. White, he had outlined a course in electrical engineering, which was begun in the fall of the same year.

Young Jackson came to Cornell two years later, at the age of 20, just at the time when he could be impressed and benefited by the fascinating discoveries which were being made in electrical science. His electrical studies formed an educational superstructure to the civil-engineering foundation. Before and during the period of his college and university life Mr. Jackson formed friendships which affected his professional career. Among the friends of this period were James G. White and Harris J. Ryan. Mr. White had graduated in the arts course at Pennsylvania State College in 1882 and had spent the following three years at Cornell as a candidate for the degree of Doctor of Philosophy. This he secured in 1885. Mr. Ryan was a junior in electrical engineering at Cornell in 1885 when Mr. Jackson arrived there. As the total number of engineering students at that time was very small, there was excellent opportunity for close acquaintance. Hence it was possible for graduate student and junior to appreciate each other's good qualities. After securing his doctor's degree, Mr. White took a position as Instructor in Physics, in charge of the department, at the University of Nebraska. This he held from 1885 to 1887, during which period Messrs. Jackson and Ryan completed their studies. Mr. White had, in the meantime, come to appreciate the engineering possibilities in the electrical field, and with Messrs. Jackson and Ryan in 1887 he organized the Western Engineering Co. to do a general electrical-contracting business. Mr. White was President of the company and Mr. Jackson was Vice-President and Chief Engineer. Mr. W. M. White, a brother of the President, joined the organization soon after its formation. The company went to work aggressively, installing and operating electrical equipment. Among those early installations were the alternating-current electric-lighting plant at Lincoln, Neb., the direct-current hydro-electric plant at Kearney, Neb., which the company also operated, and a number of lesser plants for commercial and isolated service in Nebraska, Kansas, Iowa and South Dakota. The Sprague Electric Railway and Motor Co. had, after many tribulations, overcome the most serious difficulties in the application of the electric motor to light street traction, in connection with the road in Richmond, Va., which was electrified in 1887. This success demonstrated the practicability of electric traction as a substitute for horse and mule power, and a number of contracts were immediately secured by the company. The Western Engineering Co. took up this line of work and installed Sprague apparatus in Omaha and Plattsmouth, Neb., in St. Joseph, Mo., Salt Lake City, Utah, Sioux Falls, S. D., Nashville, Tenn., St. Louis, Mo., and elsewhere. A mill-tramway plant of considerable length and with heavy grades was also installed at Kearney, Neb. While engaged in these important undertakings, by day, Messrs. Jackson and Ryan continued their engineering studies at night. By means of a small, laminated-field motor which they borrowed from the physical laboratory of Cornell University they discovered some principles of repulsion motor reactions which were afterward made the basis of a fundamental patent.

The Western Engineering Co. and its business were purchased in 1889 by the Edison interests which by this time had become very powerful. Mr. White entered the employ of the Edison United Manufacturing Co. with headquarters in New York City. He soon afterward went into business for himself and gradually built up a very large engineering and contracting organization. Mr. Ryan had left the Western Engineering Co. in 1888 to become an instructor at Cornell. He soon afterward achieved renown by his scientific study of electrical problems. Mr. Jackson became Assistant Chief Engineer of the Sprague Electric Railway and Motor Co., which was then

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extensively engaged in electrifying the street railways of the country. He had general charge of the outside construction after he joined the company. His headquarters were on Broad St., New York City, but his responsibilities extended over the entire country. Under his general supervision an able corps of engineers put in the electric-railway equipment in Cleveland, Milwaukee, Louisville, Salem, Mass., Troy, N. Y., and in many other cities. When the several Edison manufacturing and contracting companies were consolidated as the Edison General Electric Co., the engineering work relating to estimates and construction was put into the hands of the chief engineers of the various divisions. A few months after the consolidation Mr. Jackson was made Engineer of the Central District, with headquarters at Chicago. This office handled about one-half of the entire railway and lighting business of the company. Among the large and difficult problems of this important period were those connected with the railways of Minneapolis, St. Paul, St. Louis, Chicago, and many other cities. A number of the able engineers who assisted Mr. Jackson in this work, and who were trained by it for still more difficult tasks, have since come to occupy important places in the electrical industries.

In 1891, Mr. Jackson accepted appointment as Professor of Electrical Engineering at the University of Wisconsin, the Regents of the University having provided for the establishment of a course in that year. He continued as head of this department until 1907, when he was elected to the similar position at the Massachusetts Institute of Technology, which he still occupies. As would naturally be expected, he applied to his educational work the same general principles which had brought good results in practical work. One of the most important of these was the necessity for cooperation with and among his assistants, who were also encouraged to develop their ability and individuality without restraint. The result was the building up of a loyal and effective teaching corps at Madison. At Boston, he found a strong body of teachers already organized so that he has been able to devote attention to the promotion of a spirit of research and to strengthening the already strong bond existing between the faculty of the Massachusetts Institute and influential practicing engineers and business men.

Immediately after leaving Chicago, in 1891, to take up educational work Prof. Jackson began to establish a consulting practice. His brother, Mr. William B. Jackson, joined him after a short time, and the present firm of D. C. & W. B. Jackson was formed. The firm has handled a wide variety of important work, including the planning of a number of power plants and the superintendence of their construction. Examples of this are the plant of the Wells Power Co. of Milwaukee, and the hydro-electric plants of the Janesville Electric Co. Another branch of the work has been examining and reporting upon electric-power plants and other properties.

Prof. Jackson was chairman of the commission appointed by the city of Chicago to investigate the subject of telephone rates. The report of this commission, completed in 1907, was used as a basis for the rates authorized in the present franchise. Since 1907 the firm has been engaged in making various appraisals of electrical properties representing an aggregate money investment of approximately $150,000,000, and located in all parts of the country. The firm is regularly retained as consulting engineers for several electric-lighting plants and has acted as engineering advisors of the Massachusetts Highway Commission on the matters of the values of telephone properties and of equitable telephone rates. Very recently Prof. Jackson has been retained by the British Government as expert in the valuation of the property of the National Telephone Co., which is to be purchased by the Government. All such work requires a large engineering organization and a loyal and efficient field and office force has been gradually built up. While Prof. Jackson is the senior member of the firm, his first duty is to the Massachusetts Institute, so that his brother takes the leading part in the actual conduct of the business. The partners are regularly assisted by a corps of 20 or more engineers who look after the details.

As is usual with very active men, Prof. Jackson has done, and is doing, a number of things outside of his immediate business. While not robust he has learned to conserve his energy so that he can accomplish a great deal of work. In addition to his firm work, he has acted as patent expert for the Cutler-Hammer Manufacturing Co. and for several of the independent manufacturers of telephone apparatus. He is the author, or joint author, of several standard books on electrical engineering. He has written numerous papers for scientific and other societies. Among the most important of the recent papers is one in which are embodied the results of his long experience in public-service matters. This was published in 1908 and is entitled "Equitable Rate Making by Public Service Companies." It has been accepted by public-service companies and by economists as a leading and authoritative treatment of a very difficult subject. He has taken a leading part in educational matters and is recognized as a sound thinker and careful writer along educational lines. This is evidenced by his election, a few years ago, as President of the Society for the Promotion of Engineering Education and by his appointment to the educational committees of the American Institute of Electrical Engineers and the American Electric Railway Association. He is also actively interested in civic affairs, being a member of the Boston City Club and of the Boston Chamber of Commerce. As a member of the Committee on Public Utilities of the Chamber of Commerce he can make to that organization suggestions based upon actual data.

Naturally the teachers of electrical engineering are gratified that, for the third time in the past few years, one of their number has been elected to the presidency of the Institute. Teachers have always been active in Institute affairs, but there is a tendency among practical men to consider them as rather academic and, therefore, unpractical in their point of view. Teachers of Prof. Jackson's type are certainly not open to this criticism. He is making an excellent record as President of the Institute and he has had the cordial support of the influential members.

Louis Charlton Fritch, President of the American Railway Engineering and Maintenance of Way Association.

By F. R. COATES.*

The American Railway Engineering and Maintenance of Way Association had its origin at a preliminary meeting held in Chicago in October, 1898. At this meeting about a dozen representative railway engineers were present and it was decided to perfect an organization that should have for its object the scientific construction, maintenance and operation of American railways.

Mr. Louis Charlton Fritch, the present President of the association, was among those present at the Chicago meeting and was chosen secretary of the organization committee to which was delegated the duty of drafting a constitution and by-laws and perfecting a permanent organization. In conjunction with Mr. John F. Wallace and the late Augustus Torrey the work of the committee was carried out, and in March, 1899, at Buffalo, N. Y., the association was permanently organized.

The perilous period for any such movement is that of its organization, and necessarily it devolved upon the secretary to keep alive the enthusiasm and to encourage the necessary interest and spirit in others to make the organization a reality. That the work was well done and that its permanency is assured is attested by the splendid growth of the association, which today numbers nearly 1,000 members, and has accomplished an amount of work and results that has placed it in the front ranks of railway associations. Its work directly and indirectly means the saving of thousands of dollars annually to the American railways, and the standards set up by it are recognized as authoritative by the foremost engineers of our railways. There was a time in the interim between the Chicago preliminary organization meeting and the formal birth of the Association in Buffalo, when but for the persistent efforts of the secretary the association might not have been successfully launched. But to-day there is no organization which has such a record of accomplishment in so short a period as that which marks the existence of this association.

The late Augustus Torrey had the honor of being the first member enrolled and Mr. Fritch followed as the second. Owing to the lamented and untimely death of Mr. Torrey, Mr. Fritch occupies the honorable position of being the oldest living member of the association. He has grown with it from its very inception, serving successively as Secretary, Director and Vice-President; and at the annual convention of 1910 he was elected President. The association has in its present incumbent as President a man who has been through all the vicissitudes and struggles through which the association has passed, and who brings with it an experience of over a quarter of a century in active railway service, including every department of that field.

Mr. Fritch was born at Springfield, Ill., in August, 1868. He received his education in the public schools, the High School at Pana, Ill., and the Springfield Business College. He began his railway career in 1884 as Roadmaster's Assistant on the Ohio & Mississippi Ry., now a part of the Baltimore & Ohio Ry. Subsequently he took a course in Civil Engineering in the University of Cincinnati, and then became Assistant Engineer of the above road. In 1892 he succeeded the Chief Engineer in charge of the entire engineering department at the age of only 24 years, being perhaps the youngest man to occupy such a position on an important railway.

In 1893 he made a study and planned the improvement and rehabilitation of the Baltimore & Ohio Southwestern Ry. between Cincinnati and St. Louis, and later carried out this work, first as Engineer in Charge and then in addition as Superintendent in Charge of Operation. This work was one of the pioneer grade revisions in the West and stands today as an example of the thorough manner in which it was executed. Mr. Fritch has devoted many years to the investigation and study of railway economics, including both the engineering and operating features.

In 1904 he entered the service of the Illinois Central R. R. as Assistant to the General Manager, with special duties to investigate and plan a system of operation for large terminals. In 1906 Mr. Fritch was appointed Assistant to the President of that road, and brought into his new field the experience which he had obtained in the operating department. He served as a member in 1907 on the proxy committee in the Fish-Harriman fight for control of the Illinois Central R. R.

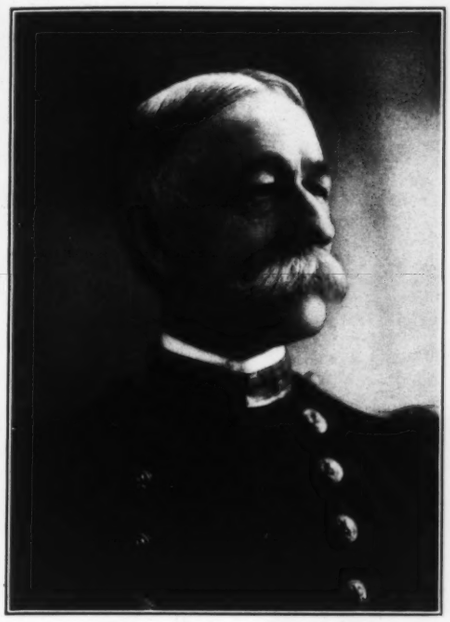
In 1909, Mr. Fritch was appointed Consulting Engineer of the Illinois Central Ry. He took up the question of the electrification of the Chicago terminals of that company and after studying every phase of the matter he rendered a report as the results of his investigation. Previously, in 1904 he had served on a committee of three to devise a system of interchange of freight traffic among the Chicago railways. The subject of electrification of steam railways and particularly of the Chicago terminals has become a public question, and sooner or later must be solved. There is no one man today who has given this subject more thorough investigation and thought and no one has more advanced opinions and ideas on the subject than Mr. Fritch.

In November, 1909, Mr. Fritch was appointed Chief Engineer of the Chicago Great Western Ry. under Mr. S. M. Felton, President.

Mr. Fritch is a member of the American Railway Engineering and Maintenance of Way Association, the American Society of Civil Engineers, the American Association for Advancement of Science, the American Railway Association's committee on Electrical Working, the National Geographical Society, the Chicago Engineers Club and the Union League Club (Chicago).

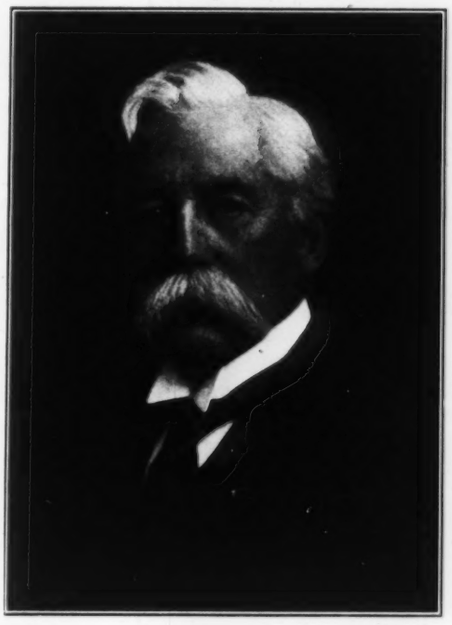
Mr. Fritch, in addition to his engineering course, also took a course in law and was admitted to the bar of the State of Ohio, but has never practiced in that profession. In 1904, Mr. Fritch married Miss Frances Myers, of Jeffersonville, Ind.

*Vice-President of the Inter Ocean Steel Co., Chicago, Ill.



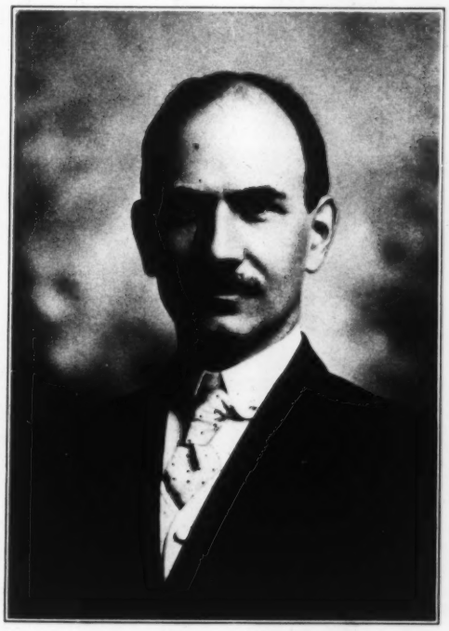
Mordecai T. Endicott

PRESIDENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.



E. D. Meier.

PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.



Dugald C. Jackson

PRESIDENT OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

L. C. Fritch.

PRESIDENT OF THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.

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Notwithstanding the low per capita water consumption of British cities, when compared with American figures, water-works men and technical journals in England often call attention to the possibility of cutting the consumption much lower by preventing waste. Thus our London contemporary, "The Surveyor," commenting on a water consumption of about 145 U. S. gals. at Toronto, Ont., says "in England 20 to 30 gals. [24 to 36 U. S. gals.] per head is considered a reasonable allowance." It continues:

> The waste of water at many places in England, and particularly in the case of small town supplies, is enormous. A loss of 50% may take place, and may go on for years without being discovered or considered. It will sometimes cause less friction to duplicate the pumps and reservoirs than to insist upon proper care in the use of water and proper plumbing work throughout a district. The case of a town duplicating its water-works instead of attending to its leaking mains and fittings is by no means unknown, while the installation of a Deacon recording meter on a trunk main has been known to cause the authorities so much alarm at the first reading, that they had the meter removed at once and tried to forget the awful revelation.

Truly, human nature is much the same everywhere. Its variations are in degree rather than in kind. "The Surveyor" rightly says that "it is difficult to compare" American and British figures of water consumption "justly * * * owing to difference of climate, differences of habit, and other conditions."

The real criterion, we may add, is how nearly do the cities of each country approach a reasonable standard of municipal efficiency in that country. In fact, this principle should be carried further so as to judge each city by its own proper standard. The only way this can be done is to determine what is use and what is waste in each city. That is impossible unless there are ready means of ascertaining the water consumption—total, by districts and by individual consumers. Metering every consumer is not in itself sufficient, because it gives no indication of leaks on the street side of individual meters nor of the surreptitious use of water by consumers small or large.

The remarks in the last paragraph should not be interpreted as meaning that nothing is to be gained by comparing per capita water consumption in different cities and countries. Such comparisons may be of value, provided they take local differences and similarities into account, for they tend to set higher standards of municipal efficiency and to stimulate rivalry in their attainment.

The Report of the Metropolitan Improvement Board on the Proposed Electrification of Steam Railways Entering Boston.

We devote considerable space in this issue to the report submitted to the Massachusetts Legislature on Jan. 30 upon the proposal to electrify the steam railway lines entering Boston.

As many of our readers are aware, there has been active agitation for several years past in a number of the larger cities with respect to the compulsory adoption of electric traction by the steam railways on their terminal lines. The fact that in New York City the terminals of the New York Central, New York, New Haven & Hartford and Pennsylvania Railroads are now operated by electricity is taken by the general public as an object lesson proving the feasibility of such operation.

As a result, Boston, Chicago, Baltimore, Philadelphia and other cities aspiring to metropolitan distinction have become ambitious to have their railway terminal lines also operated by electricity.

In Chicago a drastic ordinance to compel the electrification of all railway lines within the city limits was passed by the Board of Aldermen a year ago; and it has been intimated that if municipal compulsion is not effectual, appeal will be made to the state legislature. In Boston for some years very strong pressure has been brought to bear upon the railway companies to induce them to electrify their lines. At the last session of the Massachusetts Legislature, the companies were ordered to make investigations and estimates with respect to electrifying their terminal lines and report the results to the "Joint Board on Metropolitan Improvements." This body is composed of the members of the State Railroad Commission, the Board of Harbor and Land Commissioners, the Boston Transit Commission and the Metropolitan Park Commission, the entire Board having 16 members. This Board was ordered to investigate the whole matter and report its conclusions to the Legislature at the present session. It is this report which we present in this issue.

The Board opposes in the strongest terms any compulsory legislation whatever with reference to steam railway electrification. The experience in New York has shown that electric operation is more expensive than steam operation, and this without including in the cost of electric operation the interest and depreciation charges on the heavy cost of installing the electric system. The railway company, therefore, is burdened with these additional charges and has smaller net earnings than before with which to meet them. Had it not been that the electrification work at New York City was undertaken by three of the wealthiest of American railway corporations, it would have resulted in their bankruptcy. As it is, a comparison of prevailing prices of these companies' stocks for the past few years and their prices a decade ago, before they began their electrification work and their investments in enormously expensive passenger terminals at New York, is a most instructive object lesson.

As the Board's report points out, electrification of the steam railways entering Boston would be much more costly than at New York. In round figures, the cost of electrifying the terminal steam railways in and around Boston would amount to over $40,000,000. The cost of operation of these lines after they are electrified will be greater than before. Where is the money coming from to pay the heavy interest and maintenance charges on this $40,000,000 investment? There is no margin of profit in the present passenger business to meet this charge.

It is instructive to note the figures with reference to electrification of the Boston & Albany R. R. lines at Boston. The estimated cost of installing electricity on these lines is in round numbers $6,500,000, which would involve an annual expense to the railway company, for interest and depreciation, of about $540,000. At the present time the total gross revenue earned by the Boston & Albany's lines in this district from all the passenger traffic carried on them is only $1,300,000, and the actual operating expenses of the railway in conducting this passenger service, not including anything to the railway company for its large investment in right-of-way, tracks, and structures, is slightly in excess of the gross earnings.

It may be asked why does not the railway company increase its rates of fare so as to earn a fair profit on its investment? It could doubtless justify such an increase to the State Railroad Commission and secure necessary permission. The railway company, realizes, however, that any material increase in its fares would divert part of its traffic to the suburban electric lines which parallel it. Thus an increase in rates of fare might result in an actual decrease in its total earnings. It is, therefore, impossible for the railway company to pay the charges on the cost of electrifying its passenger lines out of its profits on passenger business, for there are no profits. Nor could it secure the necessary half million dollars per annum by raising rates of fare. The only alternative left would be an increase in its freight rates, and this would mean an added tax on the commercial and manufacturing industries in the Boston district, which would seriously handicap them in their competition with rival cities.

It is most fortunate that this public body in Massachusetts, made up of men who command public confidence as impartial judges, has had the courage and the ability to make so vigorous and able a stand against the popular move to compel the adoption of electricity on steam railway terminals. It is fortunate not only from the point of view of the railway companies' interests but in the public interest.

A good deal is being said nowadays concerning the danger to railway solvency contained in the control of the Interstate Commerce Commission over railway rates and concerning the necessity to the railways that the increase of rates they have asked for shall be granted. We believe that for the State to require railways to adopt such luxuries as electrification of terminal lines and expensive passenger stations involves a far more serious danger against railway solvency and against the welfare of the community than any power given to state or federal commissioners over the rates of fare or freight.

If railway freight rates are reduced, it simply means that a certain number of dollars less will be transferred from merchants and shippers to the railway treasuries, and this decrease in railway revenues will be partially offset by the stimulus to traffic which results from the lower freight rates. But where a railway is compelled by legislative action to adopt a more expensive method of operation in place of a less expensive, both the public and the railways will suffer.

A great deal is said about the high cost of living; but the fact is that the high cost of living is due to private and public extravagance in expenditure. Electric operation of steam railway terminals is properly characterized by the Massachusetts Board as a luxury. It would be a most serious misuse of the legislative power to compel the railways to adopt such a luxury for which the travelers and shippers of the State would have in the end to pay.

A Review of the Work of the U. S. Reclamation Service.

We print in this issue the report of the Board of Army Engineers which examined the irrigation works under the U. S. Reclamation Service last summer. The report of this Board has been awaited with much interest, in view of the criticism which have been made of the Reclamation Service.

The primary responsibility laid upon the Board was to advise on which of the Reclamation projects the fund of $20,000,000 provided by Congress at its last session had best be expended. In order to do this, however, the Board had to investigate each of the projects and the character

of the work thus far done upon it and the feasibility of each project from both the engineering and economic point of view.

As we read the report of the Board, it is a vindication—if vindication were needed—of the work done by the Reclamation Service engineers. The Board states that, "in its inspection of the various projects it was impressed with the ability of the employees occupying positions of responsibility." It says that the engineering structures are as a whole well designed and well built. It mentions particularly the Pathfinder, Shoshone and Roosevelt dams and the Gunnison tunnel as "monuments reflecting great credit on both designer and builder."

It couples with this some question as to the Belle Fourche earth dam on account of its steep side-slopes, and two other earth dams where the available material for construction was not the best. It also questions whether cheaper structures would not have served the purpose at the Laguna and the Lower Yellowstone dams.

On the whole, study of its detailed report upon the several projects shows that it found little to criticise and much to praise in the work done by the Reclamation Service engineers.

But the larger question with which the Board had to deal related to the success of the Reclamation Work as a whole. Here is a huge irrigation enterprise, or rather twenty-five different irrigation enterprises, in which the United States has embarked. It has invested in these enterprises nearly $62,000,000; and for the ultimate completion of all of them nearly $89,000,000 additional will be required. This money has been invested on the basis that the owners of the lands benefited by irrigation would repay to the United States the amount expended upon the works for supplying them with water and this money would then be available for use in the construction of further irrigation works.

Now in order that these irrigated lands shall make this payment, it is necessary that they shall be sufficiently benefited in productiveness by the application of water so that their owners may be able to pay this charge. Thus suppose the works on an irrigation project cost a million dollars to construct and will supply water to 25,000 acres. Then the benefit to these lands must be at least $40 per acre, or their owners cannot pay back to the Government what it has spent.

Evidently, then, the problem put up to the Reclamation Service administrators at the outset of the work was the selection of projects where the benefit to the lands from irrigation would at least equal the cost of the necessary works. To solve this problem it was necessary to estimate the cost and also to estimate the probable value of the irrigated land after the works were completed and water applied. These estimates of cost had to be made in many cases from incomplete data. It was not possible or advisable, of course, to go to the expense of complete surveys and detailed plans and specifications on each of several possible projects before deciding which one to select for construction. The question of selection was greatly complicated moreover by questions as to water rights and as to available supply, as to which again data were often meager. It was complicated also by the terms of the Reclamation Law, which required work to be distributed among the different arid states in proportion to the revenue from public land sales. It was hampered also, doubtless, by the pressure and influence brought to bear in favor of this or that or the other project. In fact Congressmen themselves have been frank enough to acknowledge that they were to blame in urging the Service to undertake a larger number of works than could be carried to completion with reasonable rapidity with the funds available.

Nevertheless, the success of the Reclamation Service will in the end have to be judged by the extent to which the land benefited repays the cost of the works. We have therefore examined the report of the Board and have divided the several projects into two classes. In the first class we have placed the projects which the Board approves as feasible from an engineering and economic point of view and on which it believes the benefit to the land affected is such that it can stand the charges necessary to repay the cost of the works. In this class we find 21 projects, including all the larger projects undertaken, such as the Salt River and the Yuma projects in Arizona, the Minidoka and the Boise in Idaho, the North Platte and the Shoshone in Wyoming and the Rio Grande in Texas. The total amount of Government funds allotted to these 21 projects to Dec. 31, 1910, is $57,308,000.

In the second class we have placed the projects on which the Board finds that the lands benefited are not likely to repay the whole construction cost. There are four of these projects, of which three are of comparatively small size involving a total expenditure of about $1,750,000, and the fourth, the Lower Yellowstone, involves an expenditure of a little less than $3,000,000 to the present time. The total amount expended on these four projects is $4,700,000.

What portion of this will eventually be repaid to the Government by the land owners is uncertain; but with good management it seems probable that at least $3,000,000 will be eventually repaid on the four projects—and with the ultimate increase in the value of the lands even a larger return may be made.

Of the smaller projects, that at Garden City, Kan., is a pumping system taking a supply from the underflow of the Arkansas River. The volume of this underflow was reduced by wells driven farther up the valley, and the water supplied was not economically used by the farmers, so that the water-supply is insufficient for their needs. Further and more important, in ordinary years the farmers obtain fair crops without the aid of irrigation.

A somewhat similar situation exists at the Missouri Pumping project in North Dakota, except that the water-supply here is ample. The farmers here can raise good crops in years of fair rainfall without irrigation and complain that the cost of the supply of irrigation water is greater than its benefit. The Board, however, believes that on the whole the lands will be sufficiently benefited to bear the water charge. It recommends, however, some compromise with the farmers that will enable the works to be utilized.

At the Hondo project in New Mexico, there has been a deficient rainfall since the completion of the reservoir, so that the water-supply expected has not been secured. The Board is not able to conclude from data now available whether under normal rainfall conditions a sufficient water-supply will be obtained for the lands.

It seems to us that these facts, rightly understood, indicate that a remarkable degree of sound judgment and foresight was exercised by those who selected the Reclamation projects. Here are works involving a total outlay of about $150,000,000, of which about $62,000,000 has already been expended. Out of this it appears that about $4,700,000 has been invested in works which may involve some loss; but that such loss will not probably exceed over $2,000,000 at the outside and may be considerably less.

If it should finally result that out of $150,000,000 total investment, only $2,000,000, or about 1⅓%, should be lost, the outcome would be a better showing than has ever been made by irrigation enterprises under private management. There as is well known, the proportion of "fatality" of works which when completed fail to return their cost to the original investors is exceedingly large.

Of course the Reclamation Service has had a great advantage in having no interest charges to pay and in being able to purchase and let contracts at low figures. On the other hand it is handicapped by the necessary red tape of Government restrictions and by the necessity of complying with requirements framed for other purposes than securing efficient and economical work.

But a more important question by far than the question as to the excellence of the Reclamation Service in its past work is the question of its future. The errors made in the past and the difficulties which have arisen on some of the projects have arisen, in large part at least, because of defects in the Reclamation Act as originally drafted. The framers of that act did not foresee the possibility that on some of the projects taken up the cost of the works might exceed the resulting benefit to the lands affected. They did not foresee, either, that on some of the projects the farmer's profits might not be sufficient to enable him to support his family and at the same time pay for his water right in the ten equal annual instalments which the law demands. The Board recognizes that both these features of the law require some modification on some of the projects in order that they may be placed on a basis for final success.

It would also be extremely desirable, it seems to us that in some way the excess benefits on the most advantageous works which the Government undertakes should recoup the Reclamation Fund for any losses sustained on any projects where the final cost of the works exceeds the benefit. For example, the Board's report states that on one project the mere undertaking of the work by the Government gave land which was formerly worthless a market value of $150 per acre. There are large areas on the Reclamation projects where land which was formerly valueless is now worth $50 to $100 per acre or even more, merely on the prospect of obtaining water from the Government works.

It seems to us that the law should be amended so that in some way a portion of these excess benefits should accrue to the Reclamation Fund if not at once, then eventually.

It is not to be expected that every irrigation project undertaken by the Government will show a final profit over its cost. That is not the case in any other branch of engineering construction. It is not the case with irrigation works constructed by private enterprise. It ought to be realized, therefore, that even the wisest and most competent administrators are not infallible, and have no perfect knowledge of the future.

The private investor makes his profits on good investment make up for the losses on poor ones. There is no reason why the Government should not be permitted to do the same thing in its work of land reclamation.

And there is especial need of a change in the Reclamation Act, with respect to the distribution of the cost of a given project over the lands benefited. At present this cost is distributed at a uniform rate per acre for all the land supplied with water. There is, however, on every irrigation project more or less land of inferior quality on account of soil, location, necessity of drainage or other reasons. Some of this poorer land may not be able to stand the water assessment, and there will probably be a certain percentage of loss to the Reclamation Fund on every project on this account.

It is evident that this loss is a result of the theory on which the law is based, which was that the Government should do the work of Reclamation at cost, without any profit and the gain in the value of the irrigated lands should accrue to the landowners. It is, however, absurd that on a project where the owners of the best lands are benefited hundreds of thousands of dollars, the Reclamation Fund should be depleted because some of the poorer lands on the project cannot stand the assessment.

Closely connected with this is the matter of benefits to private land owners. Of the 3,200,000 acres of land included in the Reclamation Projects, about 1,700,000 acres of land was in private ownership when the Reclamation work was started. Admittedly these private land owners as a whole have received an enormous benefit in the form of "unearned increment" to the value of their lands. Some way ought to be devised by which a part of this "unearned increment" could accrue to the Reclamation Fund.

Of course there would be intense opposition to any such change in the law, and, of course, also, it is necessary that a considerable margin of the benefit from irrigation shall accrue to the land owner, as an inducement to the settlement of the lands.

It must be remembered, however, that the Gov-

ernment is not really making a profit from the Reclamation work. If any profits were made, they would accrue to the Reclamation Fund and would be available for carrying out additional work. As a matter of fact, if even half the gain in land values which has taken place on the Reclamation Works as a result of their construction had accrued to the Government instead of to the land owners, the Reclamation Fund would be ample to-day for all needs of the work.

The Board of Army Engineers in its report urges certain legislation which is evidently needed to release the Reclamation Service from some of the restrictions by which it is now hampered. It seems to us, however, that a much more radical revision of the statute is called for. Without questioning the general wisdom of the policy pursued in the past of giving away public lands at a nominal price to actual settlers who will create farms and homes, it is at least doubtful whether a policy which brings about a wholesale scramble whenever a desirable tract of land is opened is a policy that should be perpetuated. The revolutionary changes which have taken place in land and population throughout the West should be recognized, and the Government should conduct its business on business principles.

In making these criticisms we are not necessarily blaming those who originally drafted the Reclamation Act. They did the best they could with the knowledge then available; and on the whole the results have shown the wisdom of their general plan. The experience now gained, however, has shown wherein that plan needs amendment. The importance of the Reclamation Work to the West, and indeed to the nation at large, is such that Congress should be willing to give the matter the necessary attention at the present session.

LETTERS TO THE EDITOR.

Licensing Engineers.

Sir: I am very glad to note your strong editorial in to-day's issue, concerning the proposed law licensing engineers.

I regard this as a step backward toward the "Guild" system of mediaeval times, whose only result will be to impose a tax, as you have correctly stated, on the engineering profession. It cannot serve to keep out incompetence, and to my mind is unconstitutional unless justified by the police powers of the state.

G. K. Hooper.

165 Broadway, New York, Jan. 26, 1911.

Sir: I have read with a great deal of interest, the articles both editorial and otherwise in your publication with reference to the question of the legal licensing of members of the engineering profession. In comment thereon, permit me to offer a thought that I believe is held by almost all conscientious engineers.

Almost all members of the profession that the writer has talked with on the subject lately were of the opinion that the licensing of engineers by state authority would prove a great detriment to the engineering world as well as to the capitalist who depends upon the engineer to produce for him equipments and plants which will bring him returns on his investment.

The licensing of an engineer, be he civil, mechanical, architectural, electrical or otherwise, can but discriminate by means of examinations between the engineer who is versed in the formulae of his profession and the engineer who is perhaps not so well versed in formulae and theoretical engineering but is competent to take charge of a large enterprise and the expenditure of large sums of money for his clients, and to properly meet the risks of life and limb to the general public that are more or less intimately associated with the projects upon which he has been retained.

This discrimination would place, without doubt the greatest honor upon the man who passes his technical examination with the best average, while the man of the latter class would pass with a less degree of honor as far as honor were concerned and from his record would be considered the inferior of the two.

It seems that the proper bodies to undertake the licensing of engineers are the different engineering societies. The selection of their members is usually made with a great deal of care as to the fitness of the applicant for membership therein and as a rule his experience is along the line of the branch covered by the society with which he wishes to affiliate himself.

If legal action were taken to provide that all engineers placed in responsible charge of engineering work should be members of the engineering society which covers their special branch of the profession, and the by-laws of those societies were rigidly adhered to in the selection of members, the public at large would be in a greater measure safeguarded than by any other method, as there is no body of men more capable to judge of the abilities of a man than those who are directly connected with the same kind of work. Then, too, the standing of the different engineering bodies would be brought more and more to the attention of the public and it would realize that with a member of those bodies in charge of their interests, they would have the necessary protection from the pseudo-engineer and the one with whom a little knowledge is a dangerous thing. I offer this as a suggestion for the comment of others of the profession.

Truly yours,

L. H. Gardner.

804 Lumber Exchange, Minneapolis, Jan. 28, 1911.

Some Methods of Finding the Width of a Stream.

Sir: Where it is desirable in surveying to find the approximate width of a stream of moderate size, without having to cross it, one of the following methods may be found of service. Existing formulas will probably be found more accurate for streams of considerable width, and the use of the proposed ones will be more or less limited, in consequence.

The advantages claimed over other ways are, the short time taken, and the fact that only one set-up is required.

The operations are as follows: Set up a transit on the bank, at a convenient distance from the edge of the water. Level the telescope, and have the rodman hold the rod as close as possible at the edge of the water. Take the reading, which is "$a + b$." Then depress the telescope and focus at the opposite edge of the water, and take the reading on the rod. Call this "b." If the first formula is used, the horizontal distance from the plumb line of the instrument to the edge of the water must be measured. Call this "d." Let "w" be the width sought. Then we have two similar right triangles, if the rod has been held plumb, which should be done. From the proportion of the sides,

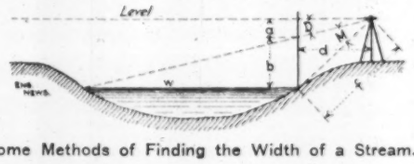
$$w = \frac{bd}{a} \qquad (1)$$

This method may be used if only a level is available, although the determination of the horizontal distance "d" to the edge of the water may be found somewhat awkward.

Where the transit is used, take the angle of depression, "D," the reading "b" as taken in the first formula, and use this formula:

$$w = b \cot D \qquad (2)$$

A third method is to obtain the inclined distance "f," from the pivotal center of the telescope to the edge of the water, and then to read the two vertical angles, one,



Some Methods of Finding the Width of a Stream.

"D," from the horizontal to the opposite side; the other, "M," from the opposite side to the nearer edge of the water, if the bank does not interfere with the line of sight. This gives three quantities in a scalene triangle, and, by the law of sines,

$$w = \frac{f \sin M}{\sin D} \qquad (3)$$

The accuracy of the first formula will be increased if the distance of the set-up from the water is nearly equal to the width of the stream, as then the two triangles approach each other in size. The second formula was found to be more accurate than the first, by actual test, across a 90-ft. stream, though it may not be in all cases. Conditions in a particular case will determine which of the three formulas is to be used.

Herbert A. Kohnhorst.

371 South Upper St., Lexington, Ky., Jan. 12, 1911.

A Diagram for Determining the Safe Load on Piles.

Sir: I enclose a diagram that I have made up for inspectors' use on pile driving. It may be of interest to your readers.

It is based on the Engineering News Formula

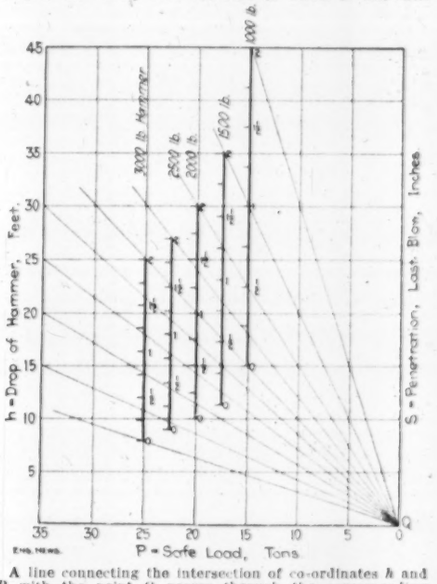
$$P = \frac{2wh}{s + 1} \text{ where}$$

P = the safe load on the pile in tons,
w = the weight of hammer, in tons,
h = the drop of hammer, in feet,
s = the penetration under the last blow, in inches.

Of course, in using the diagram one should be familiar with the limits of usefulness of the formula, which is an empirical one, and like all such formulas, may easily return abuse with absurd values.

On the diagram are scales representing the safe load, drop of hammer and penetration; the latter for hammer weights of from 0.5 to 1.5 tons. Scales of penetrations for odd weights of hammer can be interpolated.

Ordinarily the diagram is used to determine if a pile, which showed a certain penetration under the last blow of a certain weight of hammer falling from a certain height, will safely bear the load to which it will later



A line connecting the intersection of co-ordinates h and P with the point Q passes through the corresponding penetration, as given by the formula:

$$P = \frac{2wh}{1 + s}.$$

The Engineering News Formula for Safe Load on Piles in a Graphical Form.

be subjected; but any three of the four elements of P, w, h or s being given, the fourth may be found.

A note on the diagram explains its use. As an example: let h = 20 ft. and s = 5/8 ins. under a 1,500-lb. hammer. Connect the point indicating 5/8-in. on the 1,500-lb. scale with the point Q. From the intersection of the continuation of this line with a horizontal line from the 20-ft. point on the "drop of hammer" scale, let fall a perpendicular. Where this latter hits the "safe load" scale, we find 18.5 tons as the safe load.

The radial lines are drawn as guides, and in practice the diagram is used without actually drawing a line of any sort.

Very truly yours,

Arthur S. Millnowski,
Ass't. Engr., N. Y. Barge Canal.

Brockport, N. Y., Dec. 20, 1910.

[It may be well to call attention here to the fact that in the Engineering News formula as originally laid down by the late A. M. Wellington the quantity s is the average penetration per blow for the last few blows, which is assumed have been reasonably constant. The formula was not meant for use in connection with piles which are driven until they bring up solid against rock or hardpan. Such a pile is to be figured as a column. The formula is meant for piles which are driven into a stratum of clay or sand or other uniform material into which each blow sinks the pile a fairly constant amount, as the driving nears the end. The occurrence of such uniform penetration shows that the pile is in such material that the formula may safely be used for figuring its loading.—Ed.]

The "Distant Point" Method for Locating Soundings.

Sir: The hydrographic surveys, made by the Department of Inland Waterways, State of New Jersey, of the inland waterway route from Cape May to Bay Head, have covered numerous thoroughfares and several shoal sounds and bays.

The location of the soundings in the thoroughfares, which are generally deep in comparison with the sounds and bays, was made by a system of located parallel ranges intersected at regular intervals by angles measured on shore. The location of the soundings in the sounds and bays could not be made in this manner, as the ranges, if placed on shore, could not be seen, for they would be from one-half to three miles from that portion of the sound or bay whose depth was to be sounded.

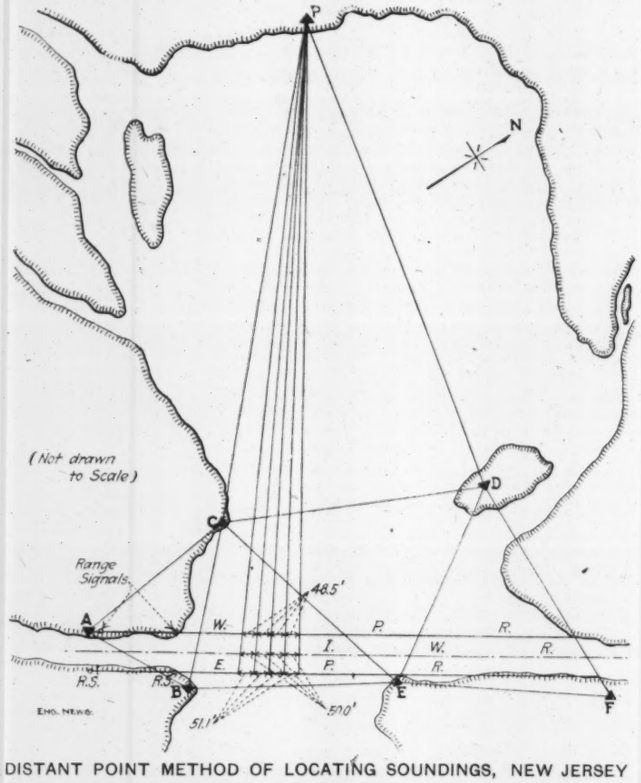
The usual method in such cases, i. e., to locate the

soundings by the intersection of two angles measured simultaneously from a known base line on shore, was employed in the early stages of the survey. In plotting the notes, the laying down of so many angles with the protractor was soon found to be cumbersome and time consuming. Moreover, the frequent failure of the transitmen's notes to agree caused no little confusion.

To save time and labor the following method, which I have called the "Distant Point Method," is now used to locate soundings across wide bays where the usual shore ranges cannot be seen with the naked eye.

Let the accompanying sketch represent some shoal sound; *IWR* the center line of the route to be surveyed, 1,000 ft. wide, and *A-B-C-D-E-F-P* the triangulation system, of which *P* is the distant point. The sound has several bars and the deepest part is about one foot deep at mean low water. *WPR* and *EPR* are western primary and eastern primary ranges; they are parallel to the center line *IWR*. The ranges *WPR* and *EPR* are located accurately from the triangulation system. Substantial and sensitive range signals are placed on shore in the line of each primary range.

The point *P* is three miles from the center of *IWR;* therefore, the two lines *PX*, *PY*, (*X*, *Y* and Z are the intersections of the radial lines from *P* with the western primary range *WPR*) drawn from *P* through the *IWR* intersecting the center line 50 ft. apart will intersect *WRP* about 48.5 ft. apart and *EPR* about 51.5 ft. apart. This gives ranges practically parallel and 50 ft. apart. The rear range signal is *P*, the distant point, and is erected high and distinct. The front range signals are 10 ft. sight poles, one with a white and one with a black flag. These poles are tied at the ends of a heavy twine 48.5 ft. long. The twine is tied so that it will be at the surface of the water after the poles have been set upon the bottom and thus does not offer much resistance to either wind or tide. The front range signals are set on the range *WPR* at *X* and *Y*, which are the length of the twine or 48.5 ft. apart. The transit is set up at *E* to measure the angles for sounding points in the southern part of *IWR*. Upon an agreed signal, the transitman observes the angle to the front range at *X;* then the sounding party in boat commences to sound at *X* and moves easterly along the range *PX*, signalling the transitman to observe angles at proper intervals until the range *EPR* is reached. The sounding party then commences on the range *PY* at its intersection with the range *EPR*, sounding in the opposite direction, until *Y* is reached. Angles are observed at the beginning and end of each range and at every fourth sounding. While range *PY* is being sounded the rodman tending the ranges in a boat, moves the signal at *X* ahead to *Z*.



DISTANT POINT METHOD OF LOCATING SOUNDINGS, NEW JERSEY DEPT. OF INLAND WATERWAYS.

After the triangulation system has been plotted in the office the front range angles are turned off along *WPR* locating *X*, *Y*, *Z*, etc., then the lines are extended from *P* through these points across *IWR*. The office work is reduced to a system of radially-located ranges, nearly parallel, intersected by angles measured from one point on shore, as in this case *E*.

Surveys made by the Distant Point Method and by the two angle intersection Method over the same bay plotted identically. The time consumed in the field was the same and the time consumed in the office by Distant Point Method was 75% less than the time taken up by the two angle intersection method.

James Logan,
Asst. Engr., N. J. Dept. of Inland Waterways.
Quarter-Boat "Pastime," Atlantic City, N. J., Dec. 13, 1910.

Gas as Fuel for Cremating Dead Animals and Incinerating Garbage.

Sir: On page 54 of "Progressive Age" of Jan. 16, 1911, is given a description of an animal crematory, which has recently been installed in Boston, Mass. In an editorial on the subject of domestic destructors in the same issue the "Progressive Age" points to this installation as an excellent illustration of a successful destructor.

Sanitary engineers will undoubtedly be interested in the installation, as the journal named hints that its principles are plain; namely, that dry material requires a long combustion chamber to prevent smoke and that wet material must be drained, dried and burned at a less high temperature. It does not state whether dogs and animals belong to the wet or dry class.

In the editorial the "Age" suggests the use of gas in a kitchen incinerator for garbage, refuse and rubbish. It will be indeed pleasant to enter the kitchen and indulge in a little garbage incineration (some thousand years hence) by means of gas. The "Progressive Age" very ably (for gas) asserts that there is

no fuel so well adapted for this purpose as gas, but the difficulty thus far has not been with the gas so much as the furnace in which it is used.

It states, also editorially,

That it is difficult to design a small furnace that will work so effectively as a larger one and this has been the trouble thus far.

This has not been the trouble, for no sensible housewife will add garbage incineration to her household duties, in modern cities, even if bone ash is worth $.02 per lb., as the "Age" states. And then again just a word to state that gas is not the fuel to use in the cremation of dogs, cats, etc., if we want to insure an efficiency in keeping with so expansive a title as "The Managing Director of the Animal Rescue League"; for this work I want to put in a word for the good old-fashioned coal.

The other day I heard Elbert Hubbard, in "vaudeville," state that

Franklin was the best all around educated man, that he was born in Boston, but did not stay there.

I do not blame him when I find that, even at this late date, it permits the slow distillation and combustion of 600 lbs. of dead dog daily, in the heart of the city, in a four-story building, in a period of two hours.

Returning to the use of coal for animal cremation, we all know that coal contains about 14,000 heat units per lb. and that Boston gas contains about 600 to 625 B. T. U.'s per cu. ft. At 80 cts. per M. cu. ft. the heating value of one ton of coal would be equal to $2,000 \times 14,000 = 28,000,000$ B. T. U., which would be equivalent to $\frac{28,000,000}{600} = 47,000$ cu. ft. of gas, which at 80 cts. per 1,000 cu. ft. would cost $37.60.

I therefore conclude from these figures that the city of Boston or rather the Managing Director of the A. R. L. has been "buncoed" by the "gas man," the self-styled illuminating engineer, who has the happy faculty of making two lights burn where one burned before and who incidentally has a method of making one and $\frac{no}{100}$ dollar earn the most dividend for the gas company.

A. N. Miller.
1128 Detroit St., Denver, Colo., Jan. 22, 1911.

Notes and Queries.

C. H. T. wishes to know if it is good practice to lay foundations on ground that has been frozen and thawed.

The general rule is that the footing course of a foundation should only be laid on solid, undisturbed earth. Ground which has been frozen and thawed is often left loose and soft because of the expansion which takes place in freezing. The amount of this expansion will depend on how wet the soil was when the freezing occurred and the nature of the soil. Certainly whenever the thawed soil appears soft and compressible, it should be excavated until solid ground which has not been frozen is reached.

A correspondent wishes to learn of any apparatus on the market for locating T or Y branches in old sewers. He states that in his town the records of Ts are in a great many cases incorrect. That, of course, entails considerable expense for digging down in an attempt to locate them. In a number of instances where Ts were not found after digging for them, our correspondent states, hub connections were made, but that is not as satisfactory as connecting to T or Y branches.

B. J. S., New York City, writes:

On reading your editorial advising efficiency engineering in the "law shops," I recall a conversation on a suburban train recently to which I was an involuntary listener. Two lawyers seated across the aisle from me were talking to each other. Said one, "What would you charge a man—a very rich man—for getting him a temporary injunction?" "Well, I would charge him $150." "That's pretty fair. I thought at first of making out a bill for $50. Then I concluded he would pay $250 if I sent him a bill for it. Yet, he is a pretty good customer and I don't want to kill him off all at once, so I think I'll charge him just what you say, $150."

I could but reflect on how different a basis the fees of an engineer and those of a lawyer are fixed. The lawyer's fee is paid without a quibble, but the engineer can never charge a really adequate fee without danger of losing his client.

The amount of structural steel for bridges to be used on the Connellsville-Cumberland extension of the Western Maryland Ry. is 14,000 tons and not 14,000 lbs. as misprinted in our issue of Jan. 26, 1911, p. 104.

W. C. S., of Philadelphia, wishes to know why a single-web plate-girder with cover-plates is to be preferred to one in which the compression flange is made up of angles only, when used for carrying a masonry wall.

Referring to the inquiry of A. O. M. in our issue of Jan. 26, Ernest McCullough, of Chicago, Ill., writes:

A complete enough treatment of conical and hemispherical roofs is found on pp. 213 to 220, inclusive, Greene's Structural Mechanics, third edition. The writer has had to design a number of reinforced-concrete roofs of conical form for silos. The roof is generally made with a rise equal to one-half the span and is reinforced with expanded metal or wire mesh. Ribs and beams inside are omitted. The stress is equal to the load in pounds per square foot multiplied by the radius in feet. This becomes a circumferential stress at the base, and reinforcement is provided in the form of a hoop of steel bars or rods. For a roof of hemispherical shape this circumferential tensile stress is equal to one-half the load in pounds per square foot multiplied by the radius in feet. For the silo roof the forms are placed as in all concrete work and the reinforcement laid upon them. Usually a very light reinforcement is sufficient. The concrete is only from 2½ to 3 ins. thick, and is usually a mortar of cement and sand only. If concentrated loads are placed on such a roof in addition to the uniformly distributed load, then the principles of the elastic arch will apply, or the treatment will be that of the elastic ring. However, this is treated in the book above mentioned.

AN APPROXIMATE FORMULA for use in the design of cone clutches for automobiles is given in a recent issue of a contemporary. The formula is $W = \frac{X}{2 \pi r 45}$, in which, W is the projected width of the friction surface of the cone measured parallel to the shaft, r is the mean radius of the cone in inches, X is the total normal component of the force of the clutch spring in pounds. This, it is stated, gives a close enough approximation to the desired pressure of 45 lbs. per sq. in. on the contact surfaces, because W does not differ much from the true width measured on the conical surface. X is computed from the axial spring pressure by the formula $X = \frac{P}{\sin \alpha}$, in which P is the total force exerted by the clutch spring in a direction parallel to the shaft, and α is the angle between the conical surface and the shaft. The complete, approximate, formula proposed then becomes

$$W = \frac{P}{2 \pi r 45 \sin \alpha}$$

While this may be close enough for practical purposes, it is hard to see wherein this formula is any simpler or easier to use than the formula

$$W = \frac{P \cot \alpha}{2 \pi r 45},$$

which can be shown by a simple computation to give the exact unit pressure desired instead of an approximation. Incidentally, the pressure per square inch should be about 5 lbs., instead of 45.

A Logical Basis for Valuations of Interurban Street Railways.*

By C. G. YOUNG,† Assoc. Am. Soc. C. E.

To-day there are operating in the United States approximately 12,000 miles of interurban electric railways, representing an investment of probably $400,000,000. The net earnings are possibly $24,000,000, or 6% on the investment, but not over 70% of the net earnings can be paid out in dividends.

The net earnings from industrials will probably average not less than 12% on the total capital invested.

There is in contemplated construction approximately 2,000 miles of additional interurban railways, every mile of which is desired by the public and which is conceded would add enormous definite financial values and advantages in the sections to be served.

To secure the building of any of these lines requires capital, which, for perfectly evident reasons, does not now seem to be forthcoming. To secure capital for the construction of an interurban electric railway, it is usually necessary to show, by carefully considered examination and report made by competent and experienced engineers in whom the investor has faith, that the road will probably earn perhaps double its fixed charges. The investor requires bonds for his investment, and if they be 5% gold bonds, they must be issued to him at a considerable discount in order to give him a minimum return of perhaps 6% from the bonds. As this return is not guaranteed, he will require in addition a considerable portion of the common stock to justify the risk he takes by investing in a new property and before the actual earnings are demonstrated.

Purpose of Valuation.

The following are some of the principal purposes that have been advanced for desiring a valuation of a property:

1. To limit the Bond Issue to the Physical Appraisal.—Probably first demanded by conservative bond dealers and investors, and is now covered by expert valuations made for them.

2. To Determine a Basis for Taxation.—Corporations generally desire to limit such valuation to the present physical appraisal, while some commissions add franchise and non-physical value. Certain commissions use net earnings capitalized. A valuation would be unnecessary if a uniform method of taxation were adopted by taking as a basis a specific percentage of the gross or net earnings.

3. To Control the Issue of Stock and Bonds.—Some commissions desire to limit total capitalization to the actual cash investment; others to the actual or estimated net earnings capitalized. This purpose of valuation would be equitable and satisfactory if used in connection with a fair rate of return on the investment, gaged by the original and subsequent risks of capital, and providing that the appraisal includes all costs of organization, construction and development of the property.

4. To Determine the Basis of Valuation for Rate Making.—This furnishes only one feature necessary for equitable rate making; the principal basis for rate making is adequate compensation for value of service rendered.

5. To Determine a Basis for the Sale and Purchase of Property, or for Future Government Ownership.—This should involve principally a determination of net earnings and estimated future earnings, also the rate of capitalization.

6. To Ascertain a Basis for Rentals on Joint Operation.—This involves the cost of reproduction and the economics of non-competition or duplication, and is not based on the net earnings.

The purpose of the valuation has a direct bearing on the method to be used in the eyes of the commissions and of the corporations, as may be noted by their usually diametrically opposite views. It is therefore advisable to carefully consider what bearing the method of valuation has upon the purpose to be accomplished.

It should be noted that if the *rate of return on the investment* is first settled, on a basis commensurate with the original and subsequent investment risks, this determination will eliminate largely the contentions between the differing interests.

The earnings of a property cannot be taken as a basis of valuation for rate making, as the earnings are directly dependent upon the rates and tariffs charged, also upon the economic conditions of location, construction, development and efficiency of management.

The question of valuation should be considered from the viewpoint of determining a reasonable rate of return, on the cost of organization, construction and development, after deducting operating expenses, depreciation and taxes.

Corporations recognize the value of good will, and are ready to capitalize it, but how frequently do they depreciate accumulated good will and in some cases entirely destroy it by adopting and following policies not in line with public opinion, whereas by taking the necessary time and trouble, it would in many cases be possible for the corporation, by adopting more reasonable tactics and through publicity to explain and fortify its position with the public and cooperate on a basis that would be mutually advantageous.

Rate of Return.

Volumes have been written on the methods, theory and practice of valuations and appraisals of public utility properties without meeting the solution of the one vital question that should first be determined, i. e., what is a fair rate of return, before any practical value can accrue from valuations and appraisals. In the writer's opinion altogether too much stress has been laid on the importance of the physical valuation as being a fair value of any property.

The courts have held that in addition to the value of the physical property there is a non-physical value to be added in order to reach a fair value of the property.

The difficulty found in most methods and theories on valuations that have come under the writer's notice and investigation is in the practical application of any scheme or basis of valuation, also by omitting the analysis and study necessary to arrive at what is to be considered and accepted *as a fair rate of return on the investment*, and until that one question is fairly met and agreed upon, there can be no right solution of the several other matters that seem to have been almost solely engaging the mind and attention of the public, government commissions, legislatures and corporations.

The courts have held that the public service corporations are entitled to earn:

A Operating expenses.
B Expenses of repairs and maintenance.
C Taxes.
D Sinking fund to cover obsolescence and depreciation.
E A reasonable profit on the fair value of the property,

from which it will be seen that the whole question rests on:

1. What is a fair rate of return on the investment?
2. What is a fair value of the property?

After the above are determined and an analysis made of the service necessary and operating details, maintenance of the property, taxes and sinking fund, it can then be determined what the proper tariffs should be to insure a reasonable rate of return on a fair value of the property.

Satisfactory results and regulation cannot be secured until the first question is determined, and the writer will hazard, as a suggestion, a basis for determining the fair rate of return, believing that if the subject is judiciously considered, it may be found acceptable to public utility properties and also to investors and the public.

A practical method of determining what is a fair rate of return on the investment may be had by considering on what basis and on what terms can funds be obtained for the construction and equipment of a new property.

The investor in a new property always considers it somewhat of a risk, even though he has faith in the final result, but his experience in the past has shown him that he would not be warranted in making an investment unless the examination and report, prepared by competent authorities, indicated that the probable net earnings above operating expenses, maintenance and taxes, are approximately equal to perhaps twice the total fixed charges, i. e., interest on the bonds issued to produce the property. The investor would not be satisfied to go into a new property if the return on his investment was to be limited to 6%, unless that amount were guaranteed, for experience shows that he takes a decided risk and may not receive even the rate obtainable by investment in "seasoned" or proved securities, therefor, he feels justly entitled to participate in any expected surplus earnings made above the fixed charges. This has been usually accomplished by issuing common shares as a bonus; the promoter, who has generally spent much time—perhaps years—as well as money to bring about the establishment of the enterprise, also feels that he is justly entitled to share in any possible surplus through ownership of a portion of the common shares. Now, if the public is fully informed that the common shares do not represent cash investment, or only partially so, no harm or wrong can accrue.

On the above basis, considering that the capital cannot be obtained unless the estimated earnings indicate approximately twice the fixed charges, it is fair to assume that the investor taking a risk attached to any new undertaking should be permitted to receive in addition to a return of interest on the bonds, a similar return on an equal amount of common shares, after which, by proper regulation of rates, or perhaps by imposing a heavy tax on earnings above the amount agreed as a reasonable rate of return on the investment, the surplus earnings could be reasonably well regulated.

Unquestionably a fair rate of return, or a reasonable profit, that can be expected on an investment in any public utility property depends principally on the risk involved in the investment.

Where the risk is low, or nil, the rate of return demanded will be a minimum. Where the risk is high, the rate of return required will be a maximum.

It is, therefore, important to the general public and the corporations to minimize the risk in order to secure investment funds upon as favorable a basis as practicable.

Anything that intimidates capital from investment in public utility properties is necessarily a destructive and wasteful condition or policy and it should be the united desire and effort of both the general public, as well as the management of such corporations, to do whatever is needful to permanently re-establish the confidence of the investors. Otherwise, every one will have to contribute in one way or another to pay for the higher rate of return justly demanded by capital supplied under unfavorable conditions.

Merely as suggestions and without attempting to say that they should be adopted, the writer gives the following tentative percentages as a fair rate of return on invested capital that would not seem unreasonable under the conditions named:

(1) Five per cent. where the interest and principal are guaranteed by the government.

(2) Six per cent. on extensions of large properties showing substantial surplus earnings.

(3) Seven per cent. on extensions of large properties showing small surplus earnings.

(4) Eight per cent. on extensions of small properties showing substantial earnings.

(5) Nine per cent. on extensions of small properties showing small surplus earnings.

(6) Ten per cent. on new properties where the estimated net earnings for the first year of operation under accepted methods are from 8% to 10% on the total cost of organization, construction and development.

(7) Twelve per cent. on new properties where the estimated net earnings under accepted methods would not pay 5% on the cost of organization, construction and development during the first three years but where ultimately it is estimated that the property would earn good dividends.

(8) A variable percentage on existing properties.

(1) Five per cent. where the interest and principal are guaranteed by the government, is not now applicable in this country, although it was found necessary for the government to guarantee the bonds in order to secure the construction of certain new steam railroads in the Philippine Islands; and it is common practice in Canada, where frequently a cash subsidy is given in addition.

(2) Six per cent. on extensions of large properties showing substantial surplus earnings, is based on probably the most favorable conditions existing in this country, and unless 6% is certain to be realized from additional investment, neither the corporation nor the investor would be warranted in making the extensions or improvements. The limitation of the originally invested capital to a 6% return would not be justified, for it has during its development period carried large risks.

(3) Seven per cent. on extensions of large properties showing small surplus earnings, which condition would usually be found in cases where the additional investment would strengthen the position of the property and add a considerable amount to the surplus earnings, but capital under such conditions would require prospects of at least 7% in return, as the risk is somewhat greater than in the preceding case.

(4) Eight per cent. on extensions of small properties showing substantial surplus earnings, being that of a smaller corporation and without the benefit of more extensive credit and resources, necessarily carries with it a higher rate of return to the investor, and 8% does not seem an unreasonable basis of expected earnings.

(5) Nine per cent. on extensions of small properties showing small surplus earnings, involves more substantial risk due to lack of any considerable surplus of earnings, and the investor will regard it somewhat in the class of a new property, and that the new extension must not only earn its fixed charges, but also a surplus on the original property, to warrant the construction of the extension, and therefore expected earnings of 9% would not be too large.

(6) Ten per cent. on new properties where the estimated net earnings for the first year of operation under accepted methods are from 8% to 10% on the total cost of organization, construction and development, is the position of a projected new property for which capital cannot be expected unless there exists a possibility, if not a reasonable probability, of receiving 10% on the investment.

(7) Twelve per cent. on new properties where the estimated net earnings under accepted methods would not pay 5% on the cost of organization, construction and development during the first three years, but where ultimately it is estimated that the property would earn good dividends, is perhaps met more frequently in projected steam railroads to be constructed in new territory not yet developed and requiring transportation facilities to make the territory valuable. As a rule, it requires several years for the development of such territory, construction of new towns and villages, and therefore a railway cannot always hope to earn interest on its bonds for the first few years, and it will be conceded that a very substantial risk is taken by the investor who undertakes to develop new territory, and therefore he is rightfully entitled to ultimately receive a correspondingly larger return on his investment.

(8) A variable percentage on existing properties.

*From a paper read at the annual meeting of the Central Electric Railway Association at Indianapolis, Jan. 19, 1911.

†Consulting Engineer, 60 Wall St., New York City.

Where bonds and stocks have been regularly issued and disposed of and where the earnings may or may not show a surplus, it is much more difficult to determine what would constitute a reasonable profit or a fair rate of return on the investment or upon the securities already issued and outstanding. This rate of return would and should vary as between the classes of properties, their extent, location, convenience, service, stability, etc.

The question of physical appraisal has been rather fully covered during the last few years and the writer finds no great difficulty, by eliminating the theoretical ideas, in harmonizing the various practical methods used or suggested in arriving at the present physical value of any property. However, very grave questions arise in the use of any basis of physical valuation to prove the real worth or value of a property. In other words, physical valuation of a property does not establish its worth or value. This holds true whether it be a new interurban electric railway which does not earn more than operating expenses, nothing towards interest, or a railway operated and maintained in first-class physical condition and earning a substantial surplus above fixed charges.

What is the worth of a small suburban electric railway which cost to construct and equip, say, $400,000, several years ago, and which has never earned its operating expenses and in fact requires about $10,000 per annum new funds to maintain operating expenses and repairs and which cannot be abandoned like an industrial.

What is the worth of another interurban electric railway that cost about $500,000 and which produces net earnings of about 10% after setting aside a proper amount for depreciation?

Surely the worth of neither property can be based on physical valuation although it is perfectly true that the physical value is one of the many factors necessary to establish its worth.

In the case of a property originally nonproductive during several years of the development period, and perhaps requiring to be reconstructed by investment of new capital, thus duplicating the original investment, before it reaches the time when it can earn interest charges, it has been suggested and approved by at least one of the State Public Service Commissions that a proper valuation would include its duplicate investment or cost of development and also the accumulated deficit capitalized, due allowances being made for charges against interest, depreciation, etc. In other words, it was assumed and granted that the property since it was first constructed was entitled to credit in a valuation to a fair rate of return on the investment from the beginning in addition to a proper amount for depreciation and therefore, if not earned and paid out, the company would be entitled to calculate the accumulated deficit and add the capitalized amount to the valuation.

It will be noted that in all of these cases it is necessary to first arrive at what constitues a fair rate of return.

Take the case of two steam railroads between two important terminal cities, one road 500 miles in length with 2½% grades and many curves serving, say, 250 miles of fair local producing territory. The other road, say, 350 miles in length, with 1% grades and few curves, serving also 250 miles of equally fair producing territory. Assume that the terminal facilities are approximately equal, or both using the same terminals, and that their present physical valuation is approximately the same. Is the worth or value of each road approximately the same? Is the physical valuation a proper gage as to the real value of either? Should both roads be held to the same tariff rates between terminals, or should each charge the same rate per ton and per passenger miles for local and through business? Unquestionably the better railroad is the shorter, direct low grade line and its worth or value is greater regardless of the question raised as to rates.

And justly so, all public utility properties—like private industrials—are entitled to the benefits of good creative judgment, good engineering and the advantages accruing to the utilization of talent in its investment. If this is not conceded, then the government must step in and guarantee a certain and definite return for all such investments alike, whether made with good judgment or otherwise, and manifestly this cannot be accepted nor would it be prudent or advisable.

Valuations.

The principal methods used in valuations of properties are:

1. Valuation Based on the Earning Power.—This basis is generally used in the purchase and sale of properties between private interests. It was also used largely by the European government in taking over private steam railroads. A valuation based on the earning power will depend entirely on the percentage rate used in arriving at the capitalized value, and is also directly dependent on the tariff rates in vogue. In other words, a property operating under high tariff charges would have a high valuation and one operating under low tariff charges would have a corresponding decreased valuation. It will therefore be seen that this method of valuation cannot advisedly be used as a basis for tariff rate making.

2. Valuation Based on Market Value of Securities.—Used by Prof. H. C. Adams of the Interstate Commerce Commission in arriving at a commercial value of railroads for the Census Bureau. This method will appeal practically to business men as indicating a commercial going value, but it should be noted that the market value of securities depends largely upon the earnings, and the earnings depend very largely upon the tariff rates in vogue, so that such a valuation may be directly affected by either a proposed, or actual, change in tariff rates and is also subject to speculative movements.

3. Valuation Based on Original Cash Cost of Organization, Construction and Development.—Less depreciation and plus appreciation. This method has great merit in arriving at a fair valuation of the property on which to calculate a reasonable rate of return commensurate with the original and subsequent risks. Such a valuation should include all cost of organization, construction and development of the property.

4. Valuation Based on the Cost of Reproducing the Property New To-day.—As if a new company were to construct and operate it. This basis of valuation has certain merit, but is considered not so equitable as No. 3. If used, the valuation should include all estimated cost of organization, construction and development.

5. Valuation Based on an Inventory of the Physical Property at Estimated Cost of Production Less Depreciation and Plus Appreciation.—This method is that usually employed by appraisers and its results depend very largely upon the personal equation of the men directing the appraisal and the previous experience of the staff employed. Its errors are principally of omission. In cases where costly changes and previous reconstruction and obsolescence of the property cannot be shown on any inventory, all of which are a necessary part of the "cost of development of the property," the question as to whether any or all of such items should be included will depend upon whether the additional expenditures have been provided out of new capital or from surplus earnings above interest charges and dividends on the original investment. A complete and accurate inventory should undoubtedly be made by every corporation as a record and information on which to gage amounts necessary for depreciation, adequate protection by insurance and to show the relative physical equity back of the bonds which is of importance principally to the purchaser of the bonds. All things considered, it is not so reasonable, reliable or fair a basis, except for limiting a bond issue, as outlined in method No. 3.

Physical Property Valuation.

The experience obtained in the appraisals heretofore made by various engineers, commissions and corporations has been valuable in the present consideration of the subject. The results obtained, however, have not been uniform, due, not only to wide variation in personal equation, but, also by including in some appraisals items which are excluded from others.

It is therefore advisable to consider what should, and what should not, be included in the appraisal of the physical property.

1. Legal expenses, including that for right of way, franchises, permits, organization, construction, etc.

2. Cost of promotion, covering expenses of preliminary investigations and reports, preliminary surveys, expenses conducting a large number of possible investors, local authorities and others over the line, in addition to the legal expenses.

3. Brokerage expenses for securing the necessary funds during the construction period.

4. Interest, or carrying charges, on all money expended up to the time the property goes into complete operation.

5. Engineering and supervision.

6. Total cost of construction, including contractors' profits on material and labor.

7. Total costs of right of way.

8. Accidents and damages, including all insurance premiums, fidelity, casualty, fire, boiler or other insurance and allowances for contributions to charitable and hospital funds.

9. Cost of complying with conditions of franchises, etc.

10. Overhead charges, including management, office rents and supplies.

11. Working capital.

12. Costs of organizing the business, securing customers, testing out entire plant and drilling new men for operating.

13. Cost of marketing and discount on the bonds (considering it as part of the price or cost at which money can be secured from the sale of the bonds).

14. Contingencies—to cover incomplete inventories, unforeseen difficulties of construction and other items of expense which can not be foreseen.

15. Obsolescence.

16. Replacements and betterments—made out of new capital investment.

17. Loss in the early operation during the period of development.

The writer will not attempt, within the limits of this paper, to indicate what would be the fair or equitable allowances or percentages to be apportioned to the various items, but to those familiar with the cost of organizing, constructing and developing properties, it is known that the items outside of actual physical construction constitute a very large part of the total cost of organization, construction and development.

Item No. 17 would be eliminated if proper consideration and margin is allowed in arriving at the percentage of return on investment—commensurate with the original and subsequent risks of capital—for in such a case the investor assumes all such possible losses at the time he considers the estimated probable return and the basis and terms upon which he makes the investment.

Franchise Valuation.

The question as to whether or not the franchise should be appraised and included in the valuation of a property has been the subject of considerable discussion and argument. Personally the writer feels that if any equitable plant of valuation can be made acceptable to all concerned without including a value for the franchise, it would be desirable, for it would immediately eliminate strong public opinion which undoubtedly stands against crediting public-service corporations with a considerable value obtained by grants from the public.

The usual basis of capitalizing the net earnings and then deducting the total physical valuation to determine the value of the franchise, is not stable, or entirely satisfactory, for the value thus determined varies with the increase or decrease of operating expenses, taxes and tariff rates and does not take into account depreciation or sinking fund, nor the difference in total physical investment and operating expenses, directly due to franchise stipulations and requirements.

Manifestly on a basis of net earnings capitalized, some franchises may have a negative value, also such value would depend directly upon the percentage rate used in capitalizing the net earnings and thus, by a comparatively small variation of this rate, the franchise value can be made large or small.

Some court decisions have recognized that what gives value to a franchise is the capital invested in the property thereby making the earnings possible, and giving to the public the conveniences and facilities desired.

In the case of an interurban electric railway, the value of its franchise might be considered on its economic basis compared with the line if built on a private right of way. The original comparative investment can be readily computed and against the increased cost in private right of way would be the saving in operating expenses and particularly the costs of maintaining tracks in city streets, pavements, and the expenses of complying with other stipulations of the franchise, together with the additional expenses of accidents and damages on streets, all of which, when capitalized, will often more than offset the increased cost of entrance over private right of way.

The value of the franchise is generally offset at the time it is granted by the stipulations and conditions imposed. Of course, after a term of years, its value may have greatly enhanced, and, therefore it is reasonable that the term of expiration be limited with possibly a renewal stipulation on a new basis of compensation to the city.

In certain cases where the municipality may desire to take over an operating company and where the method of appraising the property is not stipulated in the franchise, it is generally acknowledged proper to estimate a value for the unexpired term of the franchise. This was worked out in a systematic way in the Chicago Appraisal, where several franchises expiring at different dates were involved, viz.:

1. Gross earnings were distributed over the different divisions of the system in proportion to the car miles operated.

2. Operating expenses were similarly distributed and deducted from the gross earnings.

3. The invested capital, on the basis of physical valuation, was allocated over the various divisions and corresponding interest charges estimated at 5% were deducted from the net earnings.

4. Final value of the unexpired franchise was determined by capitalizing the estimated probable future net earnings (after first deducting interest on the physical valuation at 5%), capitalizing the yearly balances at 5% compound interest.

In the Cleveland Appraisal, good will (the result of management), was not allowed nor was any allowance made for the "going value." The value of the suburban franchises was estimated to be offset by the burden of the suburban contracts.

Capitalization.

In calculating the valuation of a property on the basis of capitalizing the net earnings, the whole question depends upon the rate used in capitalizing, and thus enormous differences in the results are obtained by only a slight change in rate. Many official appraisals have been made on a basis of 5% capitalization of net earnings, whereas, but few investors would consider the construction of any public service property if but 5% could be expected as a return, inasmuch as no minimum return is guaranteed.

The capitalization of a property should not be limited to the actual investment in the physical property or by the net earnings capitalized on a 5% or 6% basis. The only equitable basis is first to consider and determine the estimated rate of return that the original investor

expected, and that new capital would require. It is manifestly unfair to hold the total capitalization to the appraised physical value on existing property as new capital can not be secured on that basis, nor did the original investors undertake the business with that understanding.

Publicity, on a basis that will be intelligible to the general public and in simple and unmistakable form, will protect the innocent public when they wish to invest, and in cases of consolidation of companies, each having bond issues and capital shares, it can not be denied that there should be some positive regulation preventing the issuing of consolidated bonds against common shares of underlying companies where such shares originally did not represent cash invested in the property, and companies who have advocated such methods will continue to reap the censure that they deserve.

Some Public Service Commissions in their desire to protect the investor, and to prevent the corporation from going into the hands of a receiver by its failure to earn interest on the bonds, have stipulated that the property shall not be bonded for its full cost, and requires common stock to be issued for cash at par. This plan certainly does not protect the investor in the common stock and it operates to prevent the construction of new properties, that are much desired by the waiting public, and also places the existing properties in a much more advantageous and protected position. Without an incentive for both the promoter and the original investor to make a reasonable profit, above mere interest charges, progress is halted.

Securities.

Proper supervision and regulation of the issuance of securities in any public service property, or by any incorporated company for that matter, is advisable. Probably the best regulation that could be affected would be adequate and intelligent publicity, and limiting or controlling the issues as follows:

Bonds against the cost of organization, construction and development, at the price sold, allowing for the usual discount and commissions, but limited to the estimated net earnings, until earnings increase sufficiently to carry the entire authorized bond issue.

Stock (a) as preferred shares, representing that portion of the cost of organization, construction and equipment which is not covered by the bond issue.

(b) As common shares, without carrying any stated par value—representing the basis of subdivision for the distribution of estimated expected profits.

The stock and bond law of Texas appears to have been narrowly interpreted by the State Commission, and therefore does not seem as good, nor as sound, as the Massachusetts law which has regulated excessive capitalization and at the same time protected capital from unreasonable or destructive competition. The New England Commissioners have done a good service to both the public and the public-utility properties by preventing unfair and unnecessary competition and its consequent destruction of values and investments. At the same time, it has properly regulated the properties.

HIGH-TENSION UNDERGROUND CABLES.—Tests carried out by Messrs. W. Reichel and M. Gerstmeyer of the Charlottenburg Polytechnic Institute, in the Siemens-Schuckert Laboratory, are reported by Dr. Leon Lichenstein in a paper in the "Elektrotechnische Zeitschrift," translated for the "London Electrician" of Jan. 27. It appears here that a three-core cable, 61 m. long and 67 mm. diameter outside the lead covering, was taken for test. This cable withstood a pressure of 220,000 volts for 18 minutes without breaking down. Difficulties arose at the ends of the cable, which were accordingly immersed in oil. A few days later the same cable withstood a pressure of 270,000 volts for one minute, but at 330,000 volts the oil containers broke down, the cable remaining uninjured. This is taken as indicating that ordinary commercial cables will be developed in the future to withstand as high as 50,000 volts, working potential.

The Work on the Raising of the Maine.

The accompanying photograph, taken in Havana harbor, about a month ago, illustrates the wreck of the Maine, and the progress thus far made in sinking the cylinders of steel sheet-piling, which are eventually, according to the plans, to form a cofferdam around the vessel. The photograph will be found of interest, we believe, in connection with the recent discussion in these columns concerning the method adopted for building this cofferdam.

We understand that the work has been suspended for some weeks; but whether because of exhaustion of the appropriation made by Congress for this work, or for other reasons, we are not informed. We are also unable to state whether the uneven lengths of the piling forming the cylinder on the right is due to the uneven penetration of the several piles sinking through the soft mud by their own weight, or whether the pile-driver has already been used on this cylinder and has not been able to get the piles down to an even depth.

VIEW IN HAVANA HARBOR SHOWING THE PROGRESS ON THE STEEL SHEET-PILE CYLINDERS FOR THE COFFER-DAM AROUND THE "MAINE."

Keeping Records of Treated Ties.*

By F. J. ANGIER.†

Nearly all records of treated ties kept for a period of eight or more years are more or less inaccurate, or at least have so many uncertainties hanging over them as to be wholly unreliable. This may be illustrated by the record the writer attempted to keep for a period of ten years, and which is noted below. After all the trouble and expense of keeping this record, the results showed that only 102,000 ties out of a total of more than 5,500,000 (less than 2%) had been removed for all causes. On one division this record shows only five ties removed in ten years, although 433,000 had been put in track. This is absurd, and of what use are such records?

For ten years it was the practice on the Burlington Ry. to drive a dating nail in every treated tie. The first eight years the nails were driven by the section men after the ties were laid, and the last two years the nails were driven at the treating plant after the ties were treated. The head of the nail bore figures indicating the year. Every section foreman was required to make a monthly report showing the number of ties put in and taken out. Also to show the year treated and to state why they were removed.

A correct and complete record depended absolutely upon 1,500 foremen. The average section foreman is not a clerk, and not much dependence can be placed upon him to give reliable records. Then, he will be unable to decipher the figures on thousands of rusty and battered dating nails, and he either guesses at the date, or reports "illegible." No matter how many instructions are given to these men, there will be thousands of treated ties placed in the track without dating nails in them, and other thousands of untreated ties bearing dating nails which should not have been driven in them.

The record (assuming it to be complete) shows that so many ties are taken out each year, some for decay, others for rail cut, breakages, etc. But does it show that gum ties are breaking in greater numbers than elm, or that maple ties are being destroyed much more by rail cutting and spiking than beech or ash ties? Does it show whether zinc-chloride will preserve a tie as long as creosote, or that 5 lbs. of creosote per cu. ft. of timber is as economical as 8 or 12 lbs? These are some of the questions we want answered, and they never can be answered by simply putting a dating nail in every tie and depending upon the nail and the section foreman for a correct report.

After 10 years' experience with such records, the Burlington Ry. abandoned it and adopted another method. The railway is divided into 19 divisions, on each of which are placed 1,000 to 1,500 treated ties. These are carefully marked, each kind of wood is designated by a letter stamped on the head of a nail driven into the top of the tie about 34 ins. from the end. Untreated ties are marked also.

Each kind of wood, as well as each kind of treatment, is designated with nails. A careful record is kept of every charge of ties treated and used in this test, to show the details of the treatment as to seasoning, steaming, pressure, vacuum, etc., as well as the amount of preservatives injected. Whenever a tie is removed, it cannot be disposed of until permission is given from the timber-treating department. Its location in track is determined by the record. The ties are placed in one continuous stretch of track, and alternated with the different kinds of wood, and with the different methods of treatment, and with untreated ties.

This test need be made but once in ten years. The record will show not only the relative lives of treated and untreated ties, but also the relative lives of the different kinds of wood and the different processes of treatment, not only from the standpoint of decay, but also from a mechanical standpoint. It will show whether a cottonwood, a poplar, or a pine tie will fail from decay or from rail and spike, wear sooner than a birch, or a tamarack, or a hemlock tie.

Again, only 19 section foremen (instead of 1,500) are required to look after these tests. A representative of the timber-treating department personally inspects each test track once a year or oftener, as the case may require, and sees that these foremen understand and are properly looking after the tests. Suitable stakes with copper plates mark the beginning and ending of every test track.

Of course, it must be assumed that the ties in each of these 19 test tracks fairly represent the conditions of service and life of ties over the particular district in which they are located. In selecting the locality for making the tests, average conditions, as much as possible, should be considered. Two or more test tracks may be located on each division if it is found that climatic conditions vary to any great extent. The method is certainly simple and inexpensive, and is believed to be much more accurate than, and a great improvement over, the old method of placing a nail in every tie.

To put a dating nail in every tie treated on the Burlington lines (about 2,300,000 per year) would cost in round figures $8,000 a year for labor and material. In ten years this would amount to $80,000. To make the special tests, placing 5,000 ties on each division once during the ten years, would cost about $5,000. The saving in ten years would therefore be $75,000 plus interest.

*Extract from a paper read at the annual meeting of the Wood Preservers Association, at Chicago, Jan. 17 to 19, 1911.

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A POLYTECHNIC HIGH SCHOOL will be built in San Francisco, according to an announcement in the "Municipal Record" of Jan. 19. There will be, in reality two buildings—one for an academic department and facing Frederic St., the other for a manual-training and shop department and facing Carl St. The academic building will have three stories, basement and attic, while the manual-training and shop building will be only one story high, though a two-story wing at each end will extend back to the academic building. This arrangement seems necessary from the use of a side-hill plot of ground. The academic building will be 350 × 81 ft. and the manual-training and shop building 326 × 54. The wings of the latter will be 51 × 100 ft. each. In the center between the two buildings will be a paved court 100 × 200 ft. and an auditorium 70 × 98 ft. The design will be on classical lines, with details after the French Renaissance.

Report of the "Joint Board on Metropolitan Improvements" on the Electrification of the Steam Railway Lines Entering Boston.

In June last, the Massachusetts Legislature adopted a resolution requiring the steam railways entering Boston to make studies for the electrification of their lines within the Metropolitan District. These studies were to be submitted to the "Joint Board on Metropolitan Improvements" and that Board, which had then been studying the subject for a year, was to continue its work and report to the Legislature before Jan. 15, 1911.*

The report of this Board was submitted to the legislature on Jan. 30, and we reprint below the most important matter contained therein. In view of the great amount of agitation regarding the compulsory electrification of railway terminal lines, not only at Boston but at Chicago, Philadelphia, Baltimore, Washington and other cities, this report is of great interest to engineers.

Prefatory Remarks.

This Joint Board has diligently given its attention to the subject of the electrification of steam railroads entering Boston. After most careful study, the Board has been compelled to the conclusion that legislation compelling the steam railroads to electrify would be unwise and against the public interest.

It appears that to electrify the passenger traffic in the Metropolitan District would cost over $40,000,000. It also appears that experience in New York has thus far shown that electric operation is not more economical than steam operation, but is more expensive, independent of the interest on the capital required for the installation.

There are some 21 branch railway lines radiating from Boston as against 3 in the New York electrification; and the expenditure of the enormous sum above mentioned would only electrify to an average distance of 12 or 15 miles from the terminals, while in New York the expenditure of half as much carries the electrification twice as far.

Moreover, there are other elements which in the opinion of the Board render unwise at this time the hastening of electrification. In the first place, the best system of electrification is still undetermined.

Again, the problem of tunnels connecting the steam railroad stations in Boston is being considered. Any plan for a tunnel would require great changes in the terminals. Electrification should await the determination of this question.

The most serious objection to compulsory legislation, however, arises from the financial results which it would entail. There seems no reasonable ground to suppose that economies would be found that would make electrification profitable to the companies, for a considerable time to come. Judging from the experience in New York, it would entail a loss in excess of the interest on the new capital required. It would thus be necessary to raise the suburban passenger rates in order to furnish the required revenue.

Just here is where the situation in Boston is particularly unfavorable. The street car lines radiating from Boston compete with the steam lines. A very considerable increase in fares, such as electrification might make necessary, at least for a time, might easily divert sufficient traffic from the steam lines to the street car lines to make the revenue less with increased fares than it was before with lower fares. Under such circumstances, the revenue required by the roads to finance the cost of electrification would have to be derived from the long-distance passenger traffic and from the freight traffic. Either plan would put the burden where it does not belong.

But there is a still larger question to be considered, furnishing a still more powerful argument against any compulsory legislation. Our railroads are already subject to much regulation by the state. This regulation is principally directed toward three things: the regulation of capitalization; the attainment of safety of operation; and the provision of reasonable rates and fares. Electrification does not fall within any of these classes. It is not a measure of necessity or of safety. It is a luxury—a luxury which we should all be glad to obtain, but which we may not be able to afford.

Furthermore, to provide for the natural growth of the country, our railroads must spend large sums each year for additions to their facilities for handling business—additions which are necessary, if they are to keep pace with its growth. To raise these large sums of money the railroads are dependent upon private capital, and to no small degree upon foreign capital. This capital is not as willing to invest in American railroads as it once was. It looks with suspicion and fear upon the increasing amount of state and Government regulation. The railroads cannot as easily raise the money they need as they once could, and they have to pay higher rates for it.

If, now, our state legislatures begin to enact legislation compelling the expenditure of large sums for what is only a luxury, there is serious danger that the roads will find it difficult to raise the money they need even for necessary improvements. Most unfortunate and serious financial and business results may therefore ensue from compulsory electrification. Massachusetts should not set the example.

The Board, therefore, concludes that the wisest course is to enact no legislation of any kind on this subject. This conclusion is strengthened by the fact that electrification appears to be working itself out without state interference. Rhode Island and Connecticut have enacted no such legislation. In New York the only requirement has been the discontinuance of the use of steam locomotives south of the Harlem River, a distance of 5 miles, on account of the danger of operation in the Park Ave. tunnel. Here in Boston the project for a tunnel connecting the North and South stations is being actively considered, and the New York, New Haven & Hartford R. R. Co. has petitioned the legislature for permission to acquire the control of the Boston, Revere Beach & Lynn R. R., and to construct a tunnel under the harbor to connect with it. Either of these plans, if carried out, will necessitate electric operation through the tunnel, and such operation will have to be extended to convenient points beyond the tunnel at each end. This will lead to the extension of the system, and the growth will be gradual, natural, and not forced. Even in this case some increase in revenue may have to be obtained by the roads; but there will be some other economies, due to the tunnel, which will partially offset the cost of electrification.

The Board's Report in Detail.

The railroad companies have made studies relating to the electrification of their passenger service.

From these reports it appears that the New York, New Haven & Hartford R. R. Co., if it should electrify its lines or those of the Boston & Maine, would contemplate using the same system, with certain modifications and improvements, which it has adopted for the portion of its line between Woodlawn and Stamford, using the overhead system and the alternating current.

The New York Central would also contemplate a modification of the system used upon its lines in New York. There, the alternating-current is generated and carried at a voltage of 11,000 volts by overhead conductors to sub-stations, where it is transformed and converted to direct current at 600 volts in the third rail. It would propose to use the same system in Boston, except that there would be a voltage of 1,200 volts in the third rail, instead of 600, this being a later development of the art, and one that is considered to be an improvement.

It further appears from these reports that the cost of electrifying for passenger service would be as follows:

For the Boston & Maine R. R.	$18,889,192
For the New York, New Haven & Hartford R. R.	13,862,750
For the Boston & Albany R. R. (including a credit for equipment released)	6,413,300
Total	$39,165,242

These estimates are based upon electrifying the following mileage:

FOR THE NEW YORK, NEW HAVEN & HARTFORD R. R. AND THE BOSTON & MAINE R. R.

15.46 miles of four-track road.
128.07 miles of double-track road.
32.42 miles of single-track road.
111.20 miles of yard tracks and sidings.
Total mileage, 461.62 miles of single track.

FOR THE BOSTON & ALBANY R. R.

20.90 miles of four-track road.
9.89 miles of double-track road.
25.00 miles of yard tracks and sidings.
Total mileage, 128.38 miles of single track.
Grand total, 590 miles of single track.

The New York, New Haven & Hartford R. R. estimate is based on electrifying the passenger service only. The Boston & Albany R. R. estimate contemplates electrifying also "some of the sidings and local freight stations on the main line."

The expense estimated by the Boston & Albany includes not only the cost of electrification itself—that is, the cost of power-houses, shops, machinery, transmission lines, signals and equipment—but it also includes about $1,000,000 for track and station changes made necessary. The New Haven estimate, on the other hand, is for electrification alone, and there are other expenses, necessarily involved, which have not been included. This electrification should presuppose the elimination of at least the principal grade crossings, the expense of which has not been included in the above estimates and which is already authorized by statute. It would also involve considerable changes in tracks, structures and roadbed. The addition of the incidental but necessary expenses would considerably increase the figures given above, and would bring the total cost involved in the electrification, for passenger service only, not including grade-crossing elimination, to above $40,000,000.

In studying the estimates of cost submitted by the railroad companies, it must be borne in mind that they cannot be compared on a mileage basis, although the mistake is often made of doing this. The following are the facts:

ESTIMATE FOR THE ELECTRIFICATION OF RAILROADS IN THE METROPOLITAN DISTRICT OF BOSTON.

Boston & Maine and New York, New Haven & Hartford lines (including South Terminal, but not including incidental charges):		
Total estimated cost		$32,751,942
Single-track mileage		461.62
Cost per mile		$71,000
Boston & Albany lines (including incidental charges):		
Not including equipment released:		
Total estimated cost		$7,520,300
Single-track mileage		128.38
Cost per mile		$58,000
Allowing for equipment released:		
Total estimated cost		$6,413,300
Cost per mile		50,000
Total number of passengers in and out annually:		
At North Station		25,750,000
At South Station:		
New York, New Haven & Hartford R. R.	24,750,000	
Boston & Albany	7,950,000	
		32,700,000
Total		58,450,000
All lines in Boston:		
Total estimated cost, not including equipment released nor incidental charges		$39,272,242
Total single-track mileage		590
Average cost per mile		$66,000

ELECTRIFICATION IN NEW YORK.

New York, New Haven & Hartford R. R.:		
Total estimated cost		$6,124,778
Single-track mileage		118.7
New York Central & Hudson River R. R.:		
Total estimated cost, including extension to Croton not in operation		$16,135,000
Single-track mileage in operation		140.8
Single-track mileage to be added		87.0
Total mileage electrified when extension to Croton is completed		227.8
Grand Central Station, total number of passengers in and out annually:		
New York Central R. R.	10,261,273	
New York, New Haven & Hartford R. R.	9,806,466	
		20,067,739
Total mileage electrified and in operation, 259.5 miles of single track.		
All lines in New York:		
Total cost		$22,259,778
Total single-track mileage		346.5
Average cost per mile		$64,200

In comparing these figures, however, it should be remembered that the New Haven estimate for Boston included not only the North Station, but also the entire South Terminal, the Boston & Albany estimate including only up to the terminal. It should also be remembered, with reference to the figures for New York, that the amount expended by the New York Central & Hudson River R. R. covers the cost of the power and distribution system for moving not only its own traffic, but the entire traffic of the New Haven line between Woodlawn and the Grand Central Station, and that it also covers the cost of extending the electrification to Croton, this extension not being completed. For this reason no figures are given for the cost per mile of the separate roads in New York, but only the cost per mile of the total.

A fairer unit of comparison than the distance is the train mileage. Dividing the lines to be electrified into sections, and computing the total daily train mileage of each, the following results will be obtained:

IN BOSTON.

Boston & Maine R. R.:	
Total estimated cost	$18,889,192
Total daily train mileage	7,437
Cost per daily train mile	$2,540
New York, New Haven & Hartford R. R.:	
Total estimated cost	$13,862,750
Total daily train mileage	7,375
Cost per daily train mile	$1,880
Total Boston & Maine and New York, New Haven & Hartford:	
Total estimated cost	$32,751,942
Total daily train mileage	14,812
Cost per daily train mile	$2,211
Boston & Albany R. R.:	
Total estimated cost (not including credit for equipment, but deducting incidental expenses, in order to be on the same basis as the New Haven figures)	$6,520,300
Total daily train mileage	3,619
Cost per daily train mile	$1,800
All lines in Boston:	
Total estimated cost, as above	$39,272,242
Total daily train mileage	18,432
Cost per daily train mile	$2,130

IN NEW YORK.

All lines:	
Total estimated cost as above	$22,259,778
Total daily train mileage, about	7,700
Cost per daily train mile, about	$2,870

These figures are closer than the estimate per mile, indicating that the unit is more nearly a proper one.

*The report of the Boston & Albany R. R. was made by Mr. A. H. Smith, Vice-President. The report of the New York, New Haven & Hartford R. R. was from Mr. E. H. McHenry, Vice-President. Both reports were printed, somewhat condensed, in Engineering News, Dec. 8, 1910.

The figures are, of course, not accurate. The cost of terminal work seriously affects the estimate, as well as other factors. Trains are not all alike, and the train mile is not a perfectly correct unit of comparison. A multiple-unit suburban train is not the same as a heavy through passenger train. A more accurate unit would be the car mile, or even the ton mile. It is not necessary, however, to pursue this analysis further, and the data are not available. It seems clear that the estimate for Boston agrees reasonably with what would be expected from the experience in New York.

The Board in its previous report made some reference to the advantages and disadvantages of electrical operation, among the advantages being the possibility of utilizing the space over the tracks, the saving in fuel, the diminution of corrosion of overhead structures, the saving of switching in terminals if the multiple unit system is used, and the added convenience to passengers due to the absence of smoke and cinders.

Some of these advantages are real, and would result in economy of operation. The saving in fuel is considerable and undoubted. The corrosion of overhead structures, due to the smoke and steam from the locomotives, is diminished in proportion to the amount of steam service eliminated. If the multiple-unit suburban service is used, there are certain savings in train movements, especially if the trains can be run continuously around loops at the terminals, and do not have to reverse their direction. It is unquestioned that there are elements of economy in electrification which would be immediately felt. There are also some possible elements of economy which may be found to result, but which are more or less hypothetical.

Whether the electrification of a steam road will result in any final economy, independent of the interest on the capital expended, is a matter which cannot be determined by theoretical reasoning, and must be learned by experience. The experience in New York indicates that, while there are undoubted elements of saving, electric operation under present conditions is more expensive than steam operation, independent of the interest on the capital expended.

The mistake is often made of comparing a case like the one under consideration with a case in which an entire line is operated by electricity. To electrify a few miles on one end of a railroad line, the rest of which is operated by steam, is a very different thing from electrifying an entire line. If the terminals only of a steam railroad are electrified, and steam locomotives are run to the limit of electrification, the only change is that, instead of running into the terminal station, the steam locomotives are disconnected a few miles outside. The electrification of the terminal, therefore, does not very much decrease the expense of steam operation, but adds the expense of electrical operation. It may be a measure of economy to extend electrification to a still greater distance from the terminal, because by such extension a saving can be effected in the operation by steam. This point of view affords one explanation of the fact that both the New York Central and the New Haven roads contemplate extending the limits of electrification at the New York end of their lines. These extensions are not made, we are informed, because electrical operation is cheaper than steam, but because, under the circumstances, the extension of the electrical operation already installed will allow of economy in steam operation to be made. The extension of the electrification will also not involve a corresponding increase in the expense of electrical operation. So far as present experience shows, it is definitely stated that it is not possible to electrify one end of a steam railroad for short suburban runs, and make it pay.

The case is somewhat different, and more favorable, as regards strictly suburban traffic, which begins and ends within the limits of electrification. Both the New York Central, and, to a smaller extent, the New Haven lines, run a multiple-unit suburban service in and out of New York, in addition to their through passenger service and their steam freight service, but thus far they find the expense greater than before.

The greatest obstacle, however, to speedy electrification is the large capital required, and the fact that the railroad companies would be obliged to pay interest upon the double investment—that for steam and that for electricity. The capital required for electrification, as the estimates of the companies show, is exceedingly large. Not only is the apparatus expensive, but large spare units must be provided. If a locomotive breaks down, it delays in general only the particular train which it hauls; but if an entire power station should fail, all the traffic on the line would be stopped. It is, of course, quite improbable that an entire power station would break down, but it is not beyond the limits of possibility. A boiler explosion or a fire might produce such a result. The New York Central & Hudson River R. R. Co., in its New York installation, provided two cross-connected power stations, each with a sufficient capacity, utilizing its spare unit and working overload, to carry the entire demand of the service at the rush hours, in case the other power station should fail. Moreover, duplicate transmission lines were adopted in the more important portions of the territory, so that the failure of one of the lines would still leave the other effective. In the New Haven installation at New York, the power station is stated to have an excess capacity of approximately 33%.

The problem of electrification is therefore not only an engineering one, but equally a financial one, involving providing the necessary capital to make an improvement which will result, so far as experience has yet shown, in increased expenditure for operation, with an uncertain increase of traffic to offset it.

It must be remembered that the railroad companies in this country need to spend very large sums of money each year to provide increased facilities, which are demanded in order that they may be able to carry the increased traffic which results from increasing population and business. Additional tracks, sidings, yards, structures, heavier bridges and equipment, and many other things must be provided. These things are demanded by considerations of necessity. Safety appliances are also demanded for the protection of life, such as block signals, the elimination of grade crossings, and many other expensive additions to railroad property.

Electrification, however, stands in a different position. It is, it is true, very desirable, but its desirability arises not from considerations of safety or of necessity, but mainly, if not entirely, from those of convenience. It is a luxury. The railroads can operate by steam as safely as they can by electricity. How far, then, is it wise to hasten by legislative enactment an improvement which is undoubted and which is desired by every one, but from considerations of convenience alone?

The situation in Boston is not one which affords such necessity for requiring electrification as the situation in New York. Electrification in New York was precipitated by the collision which occurred in the Park Ave. tunnel Jan. 8, 1902, which resulted in the death of a large number of persons. The atmospheric conditions had so obscured the signals in the tunnel that they were almost invisible at any considerable distance.

The operation of steam locomotives in a tunnel of any considerable length is undoubtedly not merely inconvenient, but the source of serious danger.

The requirement which led to the electrification in New York was, therefore, a reasonable one. Following the accident referred to, the legislature of New York, in 1903, directed the abandonment of steam locomotives in Park Ave. south of the Harlem River within five years, ending July 1, 1908. The act did not prescribe electrification, but simply the abandonment of steam locomotives. As a matter of fact, it was impracticable to terminate electrification in New York at the Harlem River. Just beyond this point was Mott Haven Junction, and the traffic at this point was very congested. It would have been practically impossible to stop all trains at the Harlem River and make the change of power at that point; to do so would have involved greater delay and congestion. It was, therefore, necessary to carry electrification farther out, to points where ample space was available for loops, yards and buildings, and where there was not such a heavy traffic.

These illustrations show that no arbitrary line can be fixed within which electrification should be introduced. It would be impracticable to require electrification within the artificial limits of the Metropolitan District of Boston. A reasonable plan would probably involve making the terminals on some lines at points within the Metropolitan District, and on other lines at points without. The location should be determined by traffic, and not by geographical conditions.

In Boston what public desire there is for electrification is mainly, if not entirely, on account of the increased convenience which would result to passengers and abutters by getting rid of the smoke. To do so in this case would logically require electrification not simply for passenger traffic, but also for freight traffic. In other words, aside from the construction of a tunnel between the North and South stations, which would necessarily require all trains through it to be operated electrically, there is no logical reason for requiring in Boston any electrification of steam roads, unless that electrification be for both passenger and freight traffic. If the freight traffic is electrified, the cost of the undertaking will be, of course, in excess of the estimates given above.

It is true that in New York the New York, New Haven & Hartford R. R. is about to electrify its Harlem River & Port Chester tracks, over which its freight trains run into New York City, and its through trains to Washington, the work to include electrification of the freight yard at Harlem River. This fact is sometimes referred to as another apparent indication that electrification is really profitable to the railroad companies, and not difficult to carry out.

As a matter of fact, there are exceptional reasons for electrification in this particular case. Since the electrification of the main line had been carried to a point east of the junction of the Harlem River branch at New Rochelle, this branch, if operated by steam, would have been in the nature of an island, with electrical operation on both sides of it. The freight trains and the through express trains which use this branch and are ferried around New York City, would, if this branch were not electrified, have to use steam entirely, even over the electrified main line between Stamford and New Rochelle, or would have to change to electric power at Stamford and back again to steam at New Rochelle. The use of steam locomotives under the overhead system is found to be quite objectionable. It will be seen, therefore, how local conditions rendered desirable the electrification of this branch.

Since experience thus far indicates that electrification is not a source of economy, but rather the reverse, and since a return has to be earned on the additional capital necessary, and a further charge to operating expenses made for property abandoned or replaced, there seems to be no escape from the conclusion that the railroads should be allowed to increase their revenues sufficiently to provide a return on the investment large enough to attract investors. It would not be fair, even if it were possible, to require the railroad companies to expend 40 or 50 millions of dollars for electrification in Boston, unless they were also assured of an adequate return on that expenditure.

An increase in the rates of fare, however, might not increase the net revenue. A reduction of rates frequently increases the total net profits, and an increase of rates may diminish the net profits. It should be thoroughly understood, however, by commuters and others who form the short-distance passengers, that electrification of the steam roads in the Metropolitan District in all probability would, and in all fairness should, lead to an increase in the rates which they would have to pay. It should be further said that low suburban rates tend to build up the suburban territory, and to encourage and enable those who receive low wages to live away from the congested center of the city, in districts which are more healthful. From this point of view an increase in the short-distance rates is a distinct disadvantage, and would retard in many cases the building up of suburban territory.

As a result of the considerations which have been discussed, the Joint Board has reached the following conclusions:

1. The electrification of steam roads is a development much to be desired. It would add to the comfort and convenience of the public, and would have advantages for the railroads as well.

2. The best method of electrification is still undetermined. The science is in a state of rapid change, and standardization is much to be desired before extensive electrification is undertaken.

3. So far as experience has yet shown, the electrification of the terminals of steam railroads under present conditions does not result in economy, but, on the contrary, in increased expense, aside from the interest on the first cost incurred.

4. If a greatly increased traffic should result from electrification, this expense would be reduced, and might ultimately be changed to a profit.

5. Electrification would probably result for some time in obliging the railroads to make charges to operating expenses, due to property abandoned or replaced, in addition to interest on new capital and increased expense of operation.

6. Electrification would, therefore, in all probability require an increase of passenger fares and perhaps of freight rates, to produce the revenue required to pay for it.

7. Electrification, while desirable, is not necessary, nor is it required on grounds of public safety. It is desirable mainly, if not entirely, on account of added convenience and comfort.

8. There are other expenditures which should be made by the railroads, which are demanded by considerations of necessity, to enable them to meet the demands of increasing traffic, and which should have precedence of electrification. To compel electrification would postpone these more important improvements.

9. The railroads are already subject to much regulation by the state and the nation. To require them to expend large sums of money for electrification would make it difficult if not impossible for them to raise the capital required to move the increasing traffic of the country, and would thus hamper industrial development.

10. As a result of the foregoing conclusions, the Board believes that it is not wise nor in the public interest to enact legislation compelling any electrification of railroads.

11. To pass a bill making compulsory the electrification of the passenger traffic on all the steam railroad lines in the Metropolitan District of Boston within a stated time, as contemplated by the resolve, would be particularly unwise.

12. If a tunnel is constructed and used for passenger traffic in Boston, this would necessitate electric operation through the tunnel and for a certain distance on either end, and this would naturally lead to an extension of the electrification to a reasonable distance beyond. If the tunnel is to be used both for passenger and freight traffic, electrification must be adopted for both kinds of traffic. If the tunnel is not to be constructed at all, the demand for electrification is based on the convenience which would result to the public from diminution of smoke and noise; and this demand, if logical, should require electrification for both kinds of traffic.

13. The traffic to be handled in Boston is nearly three

times that at the Grand Central Station in New York; and, on account of the radiating traffic in Boston (as compared with the north and south traffic in New York) and the large number of lines in Boston (as compared with the single line with three branches in New York), the expense in Boston is very much greater. There is not sufficient justification for requiring the railroads to spend this sum of money here.

14. If electrification of steam roads, either for passenger or freight traffic, or both, is required by law, it should also be provided that the revenue may be increased so as to afford reasonable compensation to the roads for the expense involved, and in order to make it possible to raise the necessary capital.

15. If the expense of electrification is forced upon the railroads by legislative enactment, a fair increase of rates and fares will be inevitable, and it should fairly be laid upon Boston business. It may prove necessary to increase freight rates for this purpose. An increase of freight rates, such as the railroads are now applying for, is due to the general increase in cost of supplies and materials, and the great increases in wages of employees which have been granted in recent years. Such increase of rates would be distributed over all the traffic, and would not affect the commercial situation of Boston, as compared with other ports. An increase in freight rates or passenger fares, if made necessary by the legislative requirement of electrification in Boston, however, should fairly be laid upon the Boston business exclusively, and might add to the disadvantages under which Boston now labors.

16. The benefits of electrification in Boston will accrue mainly to the commuters and short-distance traffic, and also in a very large degree to owners of property along the lines electrified. To raise suburban fares simply would place the burden where it mainly belongs, but where it is least capable of being borne; and such action would in itself tend in some measure to discourage the development of suburban territory and to divert travel from the steam lines.

17. Electrification is probably the coming form of traction power; indeed, it is not improbable that at some time in the future all the trunk lines of the country over which there is heavy traffic will be electrified. The problem, however, is not like that of providing safety appliances, such as air-brakes, signals, standard couplers, or the abolition of the car stove and replacing it by steam heat from the locomotive. All of these matters were required from considerations of safety. The public demand for electrification, however, arises not from considerations of necessity or of safety, but from those of convenience. Considering that there are other improvements which are necessary in order to meet the demands of increasing traffic, the Joint Board believes that an improvement resting on considerations of convenience should be allowed to work itself out without legislative enactment.

18. As stated in another part of the report of this Joint Board, permissive authority should be granted for the construction of a tunnel connecting the North and South stations. If such authority is availed of, it will necessitate electrical operation and will lead gradually to the extension of such operation, as similar causes have led to such extensions in the neighborhood of New York.

19. It should be recognized that all improvements of this kind, whether they are the construction of tunnels or the electrification of lines, which afford greater facilities to the public and involve the expenditure of large sums on the part of the railroad companies, if not offset entirely by increased earnings or reduced expense, should be accompanied by such increase of fares or rates as will enable the roads to maintain a fair rate of return upon their total investment. In all such improvements the public is a partner in the undertaking. The principal benefit accrues to it, with no risk. Its attitude should be such as to encourage the legitimate and economical expenditure of capital, and to compensate it fairly and even liberally for any risks involved. Under the laws of this state there is little danger of a misuse of capital expenditures.

Geo. E. Smith,
Samuel M. Mansfield,
Heman A. Harding.
George F. Swain,
James B. Noyes,
Edwin U. Curtis,
David N. Skillings,
Ellerton P. Whitney,
Everett C. Benton.

Minority Report.

The undersigned dissent from so much of the report as relates to electrification. Without undertaking to discuss in detail the statements and conclusions set forth in said report, it is enough to say that, taken together, they amount to a declaration that electrification is for the present impracticable. In our opinion, experience elsewhere has demonstrated both the feasibility and the financial ability of railroad corporations to equip a portion of their lines with electricity, and we find no conditions in Boston or its vicinity which lead us to a different conclusion. Indeed, the officers of the New York, New Haven & Hartford R. R. Co. have stated to the Commission on Commerce and Industry, and on several occasions to the public, their purpose, if allowed to control the Boston & Maine system, which control is now effected, "to equip both systems with electricity for a considerable distance near Boston." The further proposals of this management to electrify the Boston, Revere Beach & Lynn R. R., if authority to acquire the same is granted by the General Court, is additional evidence that electrification to some extent is both feasible and within the financial ability of the companies. The studies submitted to the Joint Board by the New York Central & Hudson River R. R. Co. for the electrification of certain portions of the Boston & Albany R. R. also indicate feasibility within a cost far from prohibitive.

We are convinced that the public welfare demands some legislation with respect to electrification. While we are not in favor of legislation compelling the electrification of all steam railroads of standard gage in the Metropolitan District before a date now to be fixed, we do not believe that leaving the matter in the hands of the several railroad companies exclusively will result in as speedy action as will follow some legislative requirement plainly indicating the policy of the state.

Walter Perley Hall,
George W. Bishop,
George G. Crocker,
Horace G. Allen,
William B. de las Casas.

The undersigned dissent from so much of the report as relates to electrification, but are unable to join in the above statement of the views of the minority. We are unwilling to give our assent to all of the arguments, inferences and statements set forth in the majority report, and we believe that its whole tendency is unduly to discourage and postpone electrification, even by the voluntary action of the railroad companies. In our opinion, continued study of the subject under legislative authority, and reports to some public authority setting forth progress made, will tend to advance electrification and to promote agreement upon and adoption of that system of electrical operation best adapted for general use and for facilitating interchange of traffic between different systems.

We therefore believe that legislation should be enacted directing some public board to prosecute further investigations and make report to the legislature, and requiring the railroad companies, under the supervision of such board, to make further studies, with plans and estimates, not confined within the arbitrary limits of the Metropolitan District, and including freight as well as passenger traffic. We think that it should be left to such board to recommend compulsory legislation if and when it is found to be called for.

We are not, however, convinced of the advisability at the present time of any legislation requiring electrification. The fixing of the time within which the work of construction for electrical operation must be begun by all railroads within the Metropolitan District, even though some public authority is given the power of extending such time for good cause shown, seems to us to be compulsory legislation, the wisdom and necessity of which is yet to be demonstrated. However strong the desire of the public may be that all railroads within the Metropolitan District should be electrified, we doubt whether the problem has yet reached the stage where any form of compulsory legislation is warranted by the facts shown, or will really expedite an intelligent and comprehensive settlement of the question. We also believe that the effect of the great expense of electrification in justifying or rquiring an increase in rates of fare within the Metropolitan District should be more fully considered before any form of compulsory legislation is recommended.

Clinton White.
Josiah Quincy.

The Report of the Board of Army Engineer on the Reclamation Work.

As many of our readers will recall, the Congressional Act of June 25, 1910, authorizing a $20,000,000 loan to supplement the U. S. Reclamation fund provided that prior to the expenditure of any of this money upon any project, the project should be examined and reported on by a Board of Army Engineer officers and subsequently approved by the President.

On Jan. 5, President Taft transmitted to Congress the report of this Board with an accompanying message. Below we have printed the message and the Board's general report nearly in full. The detailed report of the Board on the separate projects makes a pamphlet of 197 pages. Those desiring to secure the complete pamphlet may purchase it from the Superintendent of Documents, Washington, D. C. (House Document No. 1262, 61st Congress, 3d Session.)

Message of the President.

To the Senate and House of Representatives:

The act of Congress approved June 17, 1902, set apart as a fund for the reclamation of arid lands the moneys received from the sales of public lands in certain of the States and Territories. The receipts into the reclamation fund to June 30, 1909, were $58,439,408. The total amount accumulated in the fund to date is estimated at $69,449,058, of which all but $6,241,058 has been allotted to the several projects. On June 30, 1910, the net investment in reclamation works amounted to $53,781,302, of which $52,945,441 had on June 30, 1910, been expended in the following primary projects:

States.	Project.	Net investment.
Arizona	Salt River	$8,430,950
Arizona-California	Colorado River	44,201
California	Orland	378,603
Arizona-California	Yuma	3,781,355
Colorado	Grand Valley	73,110
"	Uncomphagre	4,166,620
Idaho	Boise	3,373,250
"	Minidoka	2,900,886
"	Snake River storage	69,142
Kansas	Garden City	378,316
Montana	Huntley	854,420
"	Milk River	519,387
"	St. Mary	265,874
"	Sun River	599,958
Montana-North Dakota	Lower Yellowstone	2,888,880
Nebraska-Wyoming	North Platte	4,009,476
Nevada	Truckee-Carson	3,975,970
New Mexico	Carlsbad	617,965
"	Hondo	346,024
"	Leasburg	193,418
New Mexico-Texas	Rio Grande	76,060
North Dakota	Buford-Trenton	278,294
"	Williston	528,171
Oklahoma	Cimarron	8,873
Oregon	Central Oregon	40,133
"	Umatilla	1,155,985
Oregon-California	Klamath	1,880,000
South Dakota	Bellefourche	2,[illegible]
Utah	Strawberry Valley	[illegible]
Washington	Okanogan	338,[illegible]
"	Yakima	3,116,[illegible]
Wyoming	Shoshone	3,378,387
Total		$52,945,441

In addition, there had been invested in secondary projects June 30, 1910, $587,390; in town-site development, $10,955; in Indian irrigation, $198,704; and for general expenses, $38,811.

The reclamation act requires the return to the reclamation fund of the estimated cost of construction, and therefore entrymen and private landowners receiving water from such projects are required to contribute their proportion of the cost of construction, operation, and maintenance of the projects wherein their lands are located.

The total cash returns to the reclamation fund from water right building charges to June 30, 1910, were $902,822, and from water right operation and maintenance charges, $249,637. In addition, there was to June 30, 1910, an additional revenue of $2,086,174 derived from sales of town lots, sales of water, leases of power, etc., which are under the law credited as a reduction of the cost of the project from which the receipts are derived.

On June 30, 1910, the Government was prepared to supply water in reclamation projects to 876,684 acres of land, and the area of lands included in the projects now under construction amounts to over 3,100,000 acres. No new projects have been undertaken since March 4, 1909, the efforts of the Government having been directed toward the completion of the 30 primary projects theretofore undertaken.

The additions to the reclamation fund from the sales of public land, while approximating between six and seven million dollars per annum since 1902, were found to be insufficient for the completion of existing projects with such expedition as the necessities of the settlers and land owners within the projects undertaken seemed to require. I acordingly recommended the issuance of certificates of indebtedness or bonds against the reclamation fund.

The act of June 25, 1910, which authorized the issuance of not exceeding $20,000,000 of certificates of indebtedness repayable out of the reclamation fund, made the appropriation subject to the conditions that it should be expended upon existing projects and their necessary extensions, and that no part of the same should be expended until after the projects had been examined and reported upon by a board of Army engineer officers of the United States Army and approved by me as feasible, practicable, and worthy.

The board of engineers selected spent the summer in field examinations of the projects and has submitted to me its report upon each of the projects heretofore undertaken, together with recommendations as to the allotment of the proceeds of the certificates authorized to be issued. In addition, pursuant to my request, the board has submitted its recommendations for the allotment of that part of the reclamation fund derived from the sales of public lands to supplement the $20,000,000 loan and to carry on worthy projects not participating in the distribution of the loan.

The report of the board is based not only upon its field examination of the various projects but upon information derived from personal conference with the field officers and employees of the Reclamation Service and data furnished by such officers and employees. In addition, settlers, landowners, and other parties interested in the projects were given an opportunity to be heard. The board points out the importance of certain additional legislation authorizing the sale of surplus stored water

and the modification of conditions of payments for water rights on certain projects which will otherwise fail of returning their cost to the reclamation fund. The Secretary of the Interior in his annual report to me has recommended similar legislation.

The board recommended the allotment of the $20,000,000 provided by the act of June 25, 1910, to the following-named projects:

Salt River, Ariz.	$495,000
Yuma, Ariz., and Cal.	1,200,000
Grand Valley, Colo.	1,000,000
Uncompahgre, Colo.	1,500,000
Payette-Boise, Idaho	2,000,000
Milk River, Mont.	1,000,000
North Platte, Wyo. and Neb.	2,000,000
Truckee-Carson, Nev.	1,193,000
Rio Grande, N. Mex., Tex. and Mex.	4,500,000
Umatilla, Ore.	325,000
Klamath, Ore. and Cal.	600,000
Strawberry Valley, Utah	2,272,000
Sunnyside, Tieton, Yakima, Wash.	1,250,000
	665,000
Total	$20,000,000

and that the interest on the loan as provided by said act be charged against the projects on the amounts contributed for their completion.

The recommendation of the board for the tentative allotment of the general reclamation fund among the various projects for the years 1911 to 1914, inclusive, was as follows:

Yuma	$2,380,462
Grand Valley (conditional)	500,000
Uncompahgre	2,045,000
Minidoka	528,000
Payette-Boise	4,585,435
Huntley	110,000
Milk River	2,950,000
Sun River	3,278,000
Lower Yellowstone (conditional)	578,000
North Platte	2,185,000
Truckee-Carson	1,594,000
Rio Grande	1,855,000
Missouri pumping (conditional)	270,000
Bellefourche	480,000
Okanogan	13,000
Shoshone	2,000,000
Total	$25,351,897

No allotments either from the loan or from the general reclamation fund were recommended for the following projects, except for necessary maintenance and operation: Orland, Cal.; Garden City, Kan.; Kittitas, Wapato, Benton (Yakima project), Wash.; Carlsbad, N. Mex.; Hondo, N. Mex.

The last-named projects are, with the exception of the Kittitas, Wapato, and Benton, units of the Yakima project, completed or nearly completed. With respect to the said three units of the Yakima project, the board recommended development of a general system of storage reservoirs for the Yakima Valley, provided Congress authorizes the sale of excess stored water, so that the return of the cost of building of reservoirs may be secured, but did not recommend any allotment of funds for the construction of reservoirs or canals specifically for the said units.

After careful consideration of the report of the Board of Engineers, I approved the same, believing that it sets forth a plan for the distribution of the loan and of the available reclamation fund, that, from an engineering and economic standpoint, will best secure the speedy completion of those projects, which, because of their character, the needs of the settlers, treaty or interstate relations, projection of water rights, and prompt return to the reclamation fund of the moneys invested, should be given the preference in construction and completion over such projects or parts of projects which are more remote and may properly wait until a later date for construction or may secure water through private canals in the event the Government is authorized to dispose of surplus water to the owners of such canals.

My approval, however, is subject to the condition that the amounts allotted to the various projects may be adjusted and modified from time to time, as is found necessary for the intelligent and proper prosecution of the work and the advantage of the service. I have authorized the Secretary of the Interior to call upon the Secretary of the Treasury from time to time, as the same are needed, for the funds provided for by the act of June 25, 1910, in accordance with the allotments recommended by the board and approved by me.

Pursuant to the recommendations of the Secretary of the Interior and of the Board of Army Engineers, I earnestly recommend the enactment of a law which will permit of the disposition of any surplus stored water available from reclamation projects to persons, associations, or corporations operating systems for the delivery of water to individual water users for the irrigation of arid lands and the enactment of legislation which will give executive authority for the modification of conditions of payment for water rights on certain of the projects where, by reason of local conditions, the return of the cost of the projects to the reclamation fund will not be secured unless settlers are permitted to make payments on terms or conditions other than those specified in the public notices heretofore issued.

With the funds now at our disposal and the enactment of the additional legislation suggested, it is hoped that the work upon the several projects for which allotments have been made, may proceed to an early completion and that the settlers and water users upon the projects upon being furnished with water for the irrigation of their lands may be enabled to return to the Treasury the sums expended in the construction of the projects.

Wm. H. Taft.

The White House, Jan. 5, 1911.

Extracts from General Report of Board.

The board met in Washington, D. C., July 20, 1910, and undertook a general study of the scope and conditions of the various projects as set forth in the printed reports and records of the Reclamation Service, supplemented by oral statements of the director made at the request of the board. As a result of the preliminary studies it was deemed advisable to inspect all of the projects before submitting a report. These inspections were made between July 28 and Oct. 22, 1910, and, with a few exceptions, all of the projects were visited by all members of the board. Public hearings were held on each project.

The board was accompanied by the consulting engineer to the Secretary of the Interior and over most of the projects by the Director of the Reclamation Service. In each of the six geographical divisions into which the work is divided the board was also accompanied by the supervising engineer in charge of the division. The inspection of each project was made under the immediate guidance of the project engineer and his principal assistants.

In its inspection the board was impressed with the ability of the employees occupying positions of responsibility and desires to record its appreciation of the assistance rendered by them.

At the request of the board there was compiled for each project a memoir containing a history and description of the project and its principal features and pertinent information relative to water supply, lands, costs, and estimates. From these memoirs, supplemented by the annual reports and certain special communications, the statistical data in this report were obtained.

Before proceeding to the detailed consideration of each project attention will be invited to certain general features of the work of the Reclamation Service.

Twenty-five projects have been undertaken, which involve, including extensions, the irrigation of 3,200,000 acres of arid or semi-arid land, at a cost approximately estimated at $145,000,000. About $60,000,000 have been expended to date and about 600,000 acres are now receiving water. Only part of this area has been formally opened, the remainder receiving water from the Reclamation Service on a rental basis or through private canals not yet absorbed in the projects.

The reclamation fund to date aggregates $65,700,000, which includes $964,393 received to Sept. 30, 1910, on account of repayment of building charges. The accretions to the reclamation fund during the next four years, as estimated by the Reclamation Service, are as follows:

Years.	Sale of public land.	Repayments.	Total.
1911	$6,000,000	$1,000,000	$7,000,000
1912	5,500,000	1,500,000	7,000,000
1913	4,500,000	2,500,000	7,000,000
1914	4,000,000	3,000,000	7,000,000

STRUCTURES.—The engineering structures are, as a whole, well designed and well built. Some of them, as the Pathfinder Dam, the Shoshone Dam, the Roosevelt Dam, and the Gunnison Tunnel, are monuments reflecting great credit on both designer and builder.

Some of the high earth dams, such as the Bellefourche Reservoir Dam, which has a cross-section approaching the limit of safety; the Bumping Lake Dam, the material of which is not entirely suitable; and the Lower Deer Flat Reservoir Dam, where the leakage is considerable, should be kept under close observation.

In some cases, for example, as the Lower Yellowstone Dam and the Laguna Dam, it is believed that equally suitable structures could have been constructed at less cost. At one or two places work has been pushed to completion under difficulties due to floods and weather, when reasonable delay would have effected a considerable saving without great detriment to the project.

Modern irrigation being a relatively new art in this country, much freedom was allowed local engineers in the design of minor structures. While this was a wise policy in the early stages of this work, it has resulted in some complicated and unnecessarily expensive structures. With the present knowledge of the comparative merits of the different types, it is believed that standard designs of the simplest satisfactory type should be adopted for all minor structures.

WATER SUPPLY.—The most uncertain feature of nearly all the projects is the water supply. This is under State control, and in the prosecution of its work the Reclamation Service bears the same relation to the State as a private individual or corporation. In each case the filings have been made under State laws, and in some States special legislation has been enacted to prevent future encroachments on the filings of the Reclamation Service. All of the filings made by the Reclamation Service are, however, subject to the prior filings made by individuals and corporations. Where the water rights have been adjudicated, the rights of the United States are well defined, but elsewhere they are uncertain and may prove to be materially different from that assumed.

It is recommended that, wherever possible, steps be taken to secure an early adjudication of water rights on all projects where such adjudications have not yet been made, and that, pending such action, expenditures be kept within the probable right of the United States.

On some projects there is a surplus of stored water, which could be advantageously sold if that course were authorized by law. Legislation with this object in view is now pending in Congress. If the sale of surplus water were authorized, certain proposed extensions to cover private land by means of pumping could well be left to private enterprise.

LAND.—In nearly all projects the land proposed to be irrigated will, with proper cultivation and treatment, bear the construction and operation and maintenance charges. In a few cases the payments will be burdensome. In the Garden City and Missouri River pumping projects it is asserted by the settlers that the cost of pumping is prohibitive, but with better farming methods this condition may be changed.

Some complaint was made that the adopted sizes of farm units on public land are too small. These vary from 10 acres on part of the Umatilla project to 40 and 80 acres on most of the others. The size of the farm unit was fixed after consideration of the productiveness of the soil, the climate, and the value of the crops that could be raised, the intention being to limit it to an area sufficient for the support of a family. In a few cases there appeared to be some justification for the complaints, but further experience is desirable before any general changes are made.

Several Government demonstration farms are maintained by the Reclamation Service at the expense of the projects on which they are located. As a rule, they are not self-supporting, and though the cost to the settlers is not large they form a cause of discontent. Except when self-supporting and needed to supply vegetables and forage for Government use, it is believed that the maintenance of such farms should be left to the Agricultural Department.

COST.—The actual cost of completed work has almost invariably exceeded the original estimate, and in the case of some structures has been two or three times as large. This increase in cost has been the cause of much of the discontent among settlers. It was partly due to a general increase in the cost of labor and materials, partly to underestimates and an insufficient allowance for contingencies, and partly to the necessity of doing more work than was originally contemplated.

ESTIMATES.—The estimates of cost for completion adopted by the board are taken from the reports submitted by the supervising engineers, supplemented by estimates furnished by the Director of the Reclamation Service. These estimates are based on the experience gained on work already done. In some cases they are approximate only, and will require modification after further surveys and studies are made.

Some increase in estimates may be necessary, due to insufficient allowance for drainage. This is an important feature of the reclamation work, particularly when the farmers are not experienced in the economical use of water. The actual needs of the work in this respect can seldom be foreseen with any definiteness, and in consequence drainage on many of the projects has been left to be developed as the need arises.

In only a few of the estimates submitted by the Reclamation Service has any allowance been made for an interest charge. As interest at the rate of 3% must, under certain conditions, be paid on the whole or part of the $20,000,000 loan authorized by Congress to the reclamation fund, some additions to the estimates on this account will probably be necessary. Assuming that expenditures from this fund are made at a uniform rate during five years, that the repayments to the Treasury are made at a uniform rate during the following five years, and that interest must be paid for the entire period, the total interest charge would be equivalent to 3% on $10,000,000 for ten years, or $3,000,000. As it has not yet been determined whether this interest charge is to be spread over all the projects or parts of projects upon which the building charge has not yet been announced, or whether it is to be confined to projects upon which the loan is used, it is impracticable to state its effect on any particular project. It is believed, however, that the result of this added charge, whichever method is adopted, will not be sufficient to adversely affect the feasibility of any of the projects from an economic standpoint.

RETURNS TO THE RECLAMATION FUND.—The reclamation act contemplates the return to the fund of the estimated cost of the different projects and the work has been prosecuted on that basis. The estimated cost is held by the Reclamation Service to be that officially announced by the Secretary of the Interior when the project is opened, and not the preliminary estimates made when the project was undertaken, as was assumed by many of the owners of private lands within the projects. On the assumption that the announced building charge is the estimated cost contemplated by the act, the losses to the reclamation fund, except on four of the projects,

which will be referred to hereafter, will be relatively small, though, by reason of the number and large size of some of the projects undertaken, the repayments will extend over many years. If, on the other hand, the term "estimated cost," as used in the act, should hereafter be judicially determined to mean the preliminary estimate made when the project was undertaken, very large losses to the fund will occur.

In many of the projects the announced building charge on certain units has been less than the actual cost, but it is expected to compensate for these losses by making the building charge on remaining units correspondingly larger than the actual cost. In the case of public lands such adjustments can undoubtedly be made, but in the case of private lands it is questionable whether they can be required to pay any more than the proper proportion of the actual cost of the work pertaining to the unit in which the lands are situated. If this be true, the probable losses to the fund will be considerably greater than is indicated in the detailed reports.

On nearly all of the projects the Reclamation Service deals with the landowner through a water users' association. This is an incorporated body, in which each member holds as many shares of stock as he has acres of irrigable land within the project. In most of the associations the par value of the stock was fixed at what was apparently the originally estimated construction charge per acre. The land covered by the stock subscriptions of its members is bound by means of a contract between the association and the Reclamation Service.

The associations being formed in different States, vary in character and the contracts are not all alike. In most of them, however, it is provided that upon the formal opening of the project each holder of stock shall make a water-right application. If he does so, his land becomes bound for the repayment of the announced building charge. If he fails to do so, he can be dropped from the association and the lien foreclosed, but the liability in this case is apparently limited to the par value of the stock.

As the probable construction charges on many uncompleted projects will exceed the par value of the stock of the Water Users' Association, due regard for the security of the investment requires that the par value of the stock be correspondingly increased or other means taken that will accomplish the same purpose.

A positive loss will occur on the lower Yellowstone project even under the most favorable conditions of completion, and in the Missouri River and Garden City pumping projects and in the Hondo project large losses appear to be inevitable.

Under existing regulations the construction charges must be returned to the reclamation fund in ten equal annual payments. This is regarded as a hardship by the settlers on some projects, who expressed a desire for a series of graduated construction payments increasing from 1 or 2% the first year to 14 or 15% the tenth year. Should this suggestion be generally adopted, it would mean a delay of several [many?] years in the return of the first half of the investment and a corresponding delay in the completion of other work.

On some of the projects in the semi-arid regions such a modification in the terms of payment may be necessary to prevent an absolute failure of the project, but the general adoption of a system of graduated payments is not believed to be necessary or advisable.

OWNERSHIP OF LAND.—Table No. I. shows the amounts of public, State, and private land under the various projects. By public land is meant land in Government ownership, which has been or can be filed on subject to the terms of the reclamation act. In some cases land was entered shortly before withdrawal of adjoining land under the expectation that the project would be undertaken. The title in these cases did not become vested in the homesteader until several years after work on the project had been started, and in a sense such lands were quasi-public. At that time, however, as the owners were under no obligation to enter the project and as they could not be compelled to reduce their holdings below the acreage specified for private lands, the lands so held were essentially in private ownership and have been so classed. It is stated by the Director of the Reclamation Service that the area of land so entered is not large.

State lands included within a project are not, as a rule, bound to repay the construction charge. In many cases, however, the State has agreed to dispose of its land in tracts of the size adopted for the farm units with the provision that the purchaser shall apply for water and assume the building charge. There is no method of enforcing the sale of such lands nor any assurance that they will be sold within a given time. In some instances, delays of this character may adversely affect water rights and delay or reduce anticipated returns to the reclamation fund. Closer cooperation between the State and the Nation seems desirable.

In forming its opinion as to the merits of the different projects, the board has been guided by the following general considerations:

(1) Feasibility from an engineering and an economic standpoint.

(2) Character from a geographic standpoint, whether international, interstate, or intrastate.

(3) The relative amount of public land entered or subject to entry under the reclamation act.

(4) The amount of money already expended and the necessity of completion in order to insure its return, regardless of the second and third considerations.

(5) The protection of water rights pertaining to desirable extensions as contemplated by the act of Congress authorizing advances to the reclamation fund.

(6) The existence of agreements with water users' associations, private individuals, and corporations.

In making the amount of public land one of these considerations the board is actuated by the belief that the primary object of the reclamation act was the reclamation of public land with incidental benefits to such adjoining private land as must, in nearly all cases, be included in the project in order to make it feasible from an economic or an engineering standpoint.

While the community as a whole will profit by the reclamation of private lands, the greater portion of the benefits resulting from such expenditures of Government funds accrues to the original owners, and this without any investment on their part. For instance, in the Tieton unit of the Yakima project, which involves only 6% of public land, the inauguration of the project increased the value of private holdings from a merely nominal sum to about $150 per acre. These private holdings, some of which were large, are being divided up and sold to settlers, who will be required to pay the construction charge of $93 in addition to the above price.

In undertaking projects where the direct Federal inter-

TABLE I.—LANDS IN THE SEVERAL RECLAMATION PROJECTS.

Projects.	Total area, acres.	Public lands subject to reclamation act, acres.	Private lands, acres.	State and school lands, acres.	Lands under irrigation, 1910, acres.	Lands open to entry, 1910, acres.	Remarks.
Salt River	230,000	.....	216,000	14,000	127,000	....	Area dependent on water supply.
Yuma	131,000	74,000	57,000	.....	7,000	....	Includes mesa lands.
Orland	14,000	.....	14,000	.....	.....	....	Proposed extensions not included. Partly under irrigation from privately operated ditches.
Grand Valley	53,000	30,070	22,930	.....	.....	....	
Uncompahgre	140,000	34,000	106,000	.....	40,000	....	Present irrigation largely from private ditches.
Minidoka	124,500	101,600	3,100	19,800	62,000	....	
Payette-Boise	243,000	85,820	127,130	30,050	30,000	....	
Garden City	10,635	.....	10,635	.....	.....	....	Part of land irrigated with flood water.
Huntley	32,844	28,754	4,090	.....	12,000	6,000	
St. Mary Milk River	196,000	76,000	110,000	10,000	8,000	....	Area dependent on water supply. Irrigated at present with flood water.
Sun River	322,000	244,500	52,500	25,000	11,000	2,743	Area may be largely reduced on account of water supply.
Lower Yellowstone	62,280	17,000	43,280	2,000	7,000	1,600	
North Platte:							
North Side (interstate)	129,270	83,358	34,864	11,048	51,218	3,465	
Goshen Park	210,000	152,900	44,100	13,000	.....	....	Area indefinite, as surveys are incomplete.
Truckee-Carson	206,000	120,000	86,000	.....	32,000	....	Area dependent on water supply.
Carlsbad	20,047	20	20,027	.....	14,000	....	
Hondo	10,000	240	9,760	.....	.....	....	A small area irrigated with flood water
Rio Grande:							
New Mexico	110,000	12,000	98,000	.....	50,000	....	Irrigated lands lie both in Texas and New Mexico.
Texas	45,000	.....	45,000	.....	.....	....	
Missouri pumping:							
Buford-Trenton	12,035	1,400	10,635	.....	400	....	
Williston	11,147	1,000	10,080	67	2,000	....	
Umatilla	25,000	4,120	20,880	.....	15,319	2,000	Does not include proposed extension.
Klamath:							
Lower project uplands	37,000	700	36,300	.....	18,471	....	Lower Klamath Lake marsh lands omitted.
Tule Lake	35,000	31,900	3,100	.....	.....	....	
Upper subproject	16,000	1,500	14,000	500	.....	....	
Modoc subproject	18,000	9,000	8,000	1,000	.....	....	
Bellefourche	100,000	44,500	50,000	5,500	23,500	2,946	
Strawberry Valley	60,000	.....	60,000	.....	30,000	....	Does not include proposed extension.
Okanogan	8,650	1,100	7,550	.....	4,000	....	Does not include proposed extension.
Yakima:							
Sunnyside	98,596	1,346	95,980	1,270	50,000	....	
Tieton	34,500	2,034	30,184	2,282	.....	....	In part under flood irrigation.
Kittitas	67,890	4,240	61,410	2,240	.....	....	
Wapato	114,000	.....	114,000	.....	.....	....	This is all Indian land and partly under flood irrigation.
Benton	150,000	50,000	90,000	10,000	.....	....	Land unsurveyed and areas approximate.
Shoshone	164,000	153,000	1,500	9,500	15,000	14,347	Area may be largely reduced on account of water supply.
Totals	3,241,414	1,366,102	1,718,055	157,257	609,908	....	

TABLE II.—FINANCIAL STATUS OF RECLAMATION PROJECTS.

Project	Total estimated cost.	Allotments to Dec. 31, 1910.	Allotments required to complete.	Allotments recommended 1911-1914, inclusive. Fund.	Allotments recommended 1911-1914, inclusive. Loan.	Required to complete after 1914.
Salt River	$9,665,000	$9,170,000	$495,000	.....	$495,000	(1)
Yuma	7,700,462	4,120,000	3,580,462	$2,380,462	1,200,000	(1)
Orland	607,335	608,000	.....	.....	.....	(1)
Grand Valley	3,621,663	225,000	3,396,663	[3]500,000	[2]1,000,000	[2]$1,896,663
Uncompahgre	9,000,000	4,455,000	4,545,000	2,045,000	1,500,000	1,000,000
Minidoka	4,505,000	3,977,000	528,000	528,000	.....	(1)
Payette-Boise	10,852,435	4,267,000	6,585,435	4,585,435	2,000,000	(1)
Garden City	419,000	419,000	.....	.....	.....	(1)
Huntley	1,040,000	955,000	110,000	110,000	.....	(1)
Milk River	6,891,000	941,000	5,950,000	2,950,000	1,000,000	2,000,000
Sun River	10,000,000	722,000	9,278,000	3,278,000	.....	6,000,000
Lower Yellowstone	3,523,000	2,945,000	578,000	[3]578,000	.....	(3)
North Platte:						
Interstate	5,070,000	5,135,000	14,835,000	2,185,000	2,000,000	10,650,000
Goshen Park	14,900,000					
Truckee-Carson	7,000,000	4,213,000	2,787,000	1,594,000	1,193,000	(1)
Carlsbad	605,000	605,000	.....	.....	.....	(1)
Hondo	359,000	359,000	.....	.....	.....	(1)
Rio Grande	9,665,000	1,310,000	8,355,000	1,855,000	4,500,000	2,000,000
Missouri Pumping	1,195,000	983,000	270,000	[2]270,000	.....	(3)
Umatilla	1,650,000	1,325,000	325,000	.....	325,000	(1)
Klamath	4,470,195	2,334,000	2,136,195	.....	600,000	1,536,195
Bellefourche	3,150,000	2,670,000	480,000	480,000	.....	(1)
Strawberry Valley	3,407,000	1,135,000	2,272,000	.....	2,272,000	(1)
Okanogan	590,000	603,000	13,000	13,000	.....	(1)
Yakima:						
Sunnyside	3,148,000			.....	1,250,000	(1)
Tieton	3,185,000			.....	665,000	(1)
Kittitas	4,525,000	4,711,000	18,145,000	.....	.....	4,525,000
Wapato	4,205,000			.....	.....	4,205,000
Benton	7,500,000			.....	.....	7,500,000
Shoshone	7,828,000	3,828,000	4,000,000	2,000,000	.....	2,000,000
Total	.....	$61,885,000	$88,664,755	$25,351,897	$20,000,000	$43,312,858

[1]Completed. [2]Conditional. [3]Completed; conditional.
NOTE.—The allotments to Dec. 31, 1910, include allotments for operation and maintenance.

FINANCIAL SUMMARY.

Balance unallotted	$3,000,000
Estimated receipts 1911-1914	28,000,000
Loan	20,000,000
Total	$51,000,000
Allotments recommended	45,400,000
Operation, maintenance and contingencies	5,600,000
Total	$51,000,000

...ots are small it would seem no more than equitable to add an interest charge to the cost of reclaiming private land or to require that a percentage of the private holdings be deeded free of cost to the United States, the areas so deeded to be subsequently thrown open to entry under the homestead law as modified by the reclamation act.

A description of the various projects containing the recommendations of the board follows. It is supplemented by Table II., giving the total estimated cost of each project, the allotments to date, and the suggested allotments.

Respectfully submitted.

Lieut.-Col. John Biddle, Lieut.-Col. W. C. Langfitt, Major Wm. W. Harts, Major C. W. Kutz, Major H. Burgess.

Annual Convention of the Illinois Society of Engineers and Surveyors.

The 26th annual meeting was held at East St. Louis, Ill., on Jan. 25 to 27, with a large attendance of members and visitors. The meetings were held at the City Hall, and the headquarters were at the Illmo Hotel. There were seven business sessions; one afternoon was devoted to an excursion to several points of interest, and a dinner at the hotel terminated the convention. There was a good list of papers and reports, and several of these led to extended discussions.

To mark the completion of the first 25 years of the Society's career one session was devoted largely to remarks and reminiscences by past-presidents and some of the charter members and honorary members who are still connected with the Society. This was on the evening of the 26th, and was opened by Prof. I. O. Baker (the founder of the Society) with a paper reviewing its organization, history and work, together with the coincident development of the engineering department of the University of Illinois.

In the course of his paper he referred to the value of the services of Engineering News in publishing notices of the organization and reports of the proceedings in the earlier days, at a time when very little was done in engineering publicity work. In a letter read from Mr. Geo. H. Frost, Founder of Engineering News and President of Engineering News Pub. Co., and an Honorary Member of the Society, a compliment was paid to Prof. Baker for his action some 25 years ago in having a drainage contract advertised. The work had been previously in the hands of a few local firms, and the wisdom of investing money in such advertising was questioned. The advertising, however, brought numerous bids from various parts of the country. In this way the cost of the work was reduced so greatly that on such work in succeeding years the Illinois taxpayers have been saved millions of dollars. Prof. Baker in reply referred to this early experience as an indication of the value of "engineering advertising."

The report of the Committee on Water-works dealt with the relation of stream pollution to water-supply, and the legislation enacted by various states for the prevention of such pollution. In Illinois, an act is proposed which is based upon laws already in force in Ohio and Indiana and puts the control in the hands of the State Water Survey.

A paper on the Catskill Aqueduct for the new water-supply of New York was read by Prof. Baker. The report of the Committee on Sewers presented statistical tables of the sewerage systems of a number of Illinois cities. It referred also to the question of the durability of concrete pipe and tile. There was little doubt as to the efficiency of well-made material, but this industry was held to be passing through the experience of the concrete building-block industry in earlier years. That is to say, there is a widespread idea that the only thing necessary is to mix a little (very little) cement with any kind of sand or gravel, put it through a pipe machine, and begin to make money in the business. The result is the production of much inferior material, the unsatisfactory behavior of which throws discredit upon concrete in general. Makers of other kinds of pipe are not slow to make capital out of this state of affairs, but the development of better methods of manufacture was believed to remedy these conditions.

Sewage disposal and purification were dealt with in a separate part of the report. Mr. L. K. Sherman presented a paper on "the Calumet Drainage Canal," a branch of the Chicago main drainage canal which is to be commenced this spring.

A paper on "Vital Statistics in Illinois," by Dr. Geo. W. Webster (President of the State Board of Health) outlined the importance of correct vital statistics in their relation to matters of public health, and showed that Illinois is deplorably behind the times in not having a satisfactory law for the registration of births and deaths. The paper was particularly appropriate for the reason that the opposition to such a law comes largely from that section of the state in which East St. Louis is located. Without such records as the law would make available, it is not possible to determine the death rate, or to determine what effect on the death rate is brought by the various engineering works, the investigations and improvement of water-supply, the anti-tuberculosis crusade, etc. While records are kept of blooded horses and cattle, a human being may be buried without any legal notice or record.

> What a disgrace to our state [Illinois] that we should be found holding open the door for graveyard insurance. When a human being can pass, or be sent, from this world to the next without a single formality, inquiry into or record of the cause of the death, and the body buried like that of a dog, it is time we enacted and enforced a suitable law, if for no other reason, as a deterrent of crime.

The matter was thus stated very succinctly and forcibly by Dr. Webster. A resolution was adopted expressing appreciation of the conditions and approval of the law now proposed.

The report of the Committee on Drainage included a review of the progress of agricultural drainage, and a detailed statement of the cost of operation of a drainage pumping plant having two 250-HP. tandem-compound engines directly connected to two 50-in. centrifugal pumps. With a total pumpage for one year equivalent to 0.995 ft. depth of water on 16,000 acres the cost of pumping averaged 34.8 cts. per acre. Mr. E. E. R. Tratman (Associate Editor of Engineering News) presented a paper on "Excavating Machinery for Ditches and Trenches." This was illustrated by stereopticon views of different types of machines.

Road and street paving received a large share of attention. A point brought out in the report of the Committee on Roads and Pavements was in regard to asphalt filler for brick paving. An objection to this filler is its cost, and this cost is due largely to the method of application. The plan suggested is to pour the filler from a can having a fan-shaped spout ¼-in. wide and 6 ins. long, and to remove all surplus material by means of a squeegee. As chilled asphalt will not flow from a spout of this width, the method will ensure the use of hot asphalt. Another point referred to was the necessity of proper maintenance of pavements, and the possibility of material economies due to such maintenance. With any kind of paving construction, it is essential that the engineer should see that the specifications are complied with.

Mr. A. N. Johnson, State Highway Engineer of Illinois, showed some views illustrating the effect of automobiles at various speeds upon macadam roads. He presented also a paper on a piece of road work near East St. Louis, which involved special drainage problems due to the severe washing of banks and saturation of roadbed in a fine siliceous formation. A paper by Mr. T. R. Agg, of the staff of the Illinois Highway Commission discussed experiments in the bituminous treatment of macadam and earth roads. Mr. H. E. Bilger (of the same staff) dealt with improved types of highway bridges, and a method of estimating the quantities and costs of concrete abutments for steel bridges. An interesting talk on highway conditions in Missouri was given by Mr. Curtis Hill (State Highway Engineer of Missouri), who predicted the use of brick paving in certain districts which have deposits of shale but no hard material for ordinary road surfacing.

On the subject of surveying, Prof. W. H. Burger (Northwestern University) presented an interesting paper on the precise dumpy levels designed by the U. S. Coast and Geodetic Survey (with which he has been connected), and also the methods used by the Survey in its precise leveling. The report of the Committee on Surveying pointed out the necessity for greater uniformity in records, better public records, and better monumenting of surveys.

A paper by Mr. H. H. Rankin, a county surveyor for 21 years in one county, pointed out the disadvantages of county surveying. He urged that this should be abolished, and that there should be a county engineer (with requirements as to technical education and ability). The engineer would have supervision of road and bridge work, and all surveys would have to be recorded in his office. A paper by Mr. E. McCullough, which was read by title, took the view that if engineers are to be licensed this should be under a federal law and not under state laws. A paper by Mr. A. H. Baer (Belleville) on the local improvement law of Illinois called forth a protracted discussion.

An interesting feature of the proceedings was the presentation of a series of papers describing the engineering works around about East St. Louis. These proved of particular interest to the visiting engineers, and they were read at the session preceding the excursion, thus explaining many of the points which were visited later. Mr. W. J. Crocken (City Engineer) opened with a paper on the municipal engineering features, and Mr. W. A. Thompson (Assistant City Engineer) followed with one on the outlet sewer to replace the present four outlets. During high water in the river, the outlet will be closed and the sewage pumped by two centrifugal pumps with 175-HP. gas engines. At the same time the drainage of the district will be pumped by five similar pumps with 275-HP. engines. The pumping station includes a producer plant.

The water-supply system was described by Mr. H. H. Horner, Constructing Engineer of the City Water Co. A pumping station takes water from the Mississippi River and delivers it to a low-service reservoir and there is a high-service station for fire protection, manufacturing and domestic uses. The former plant has two engines of 10,000,000 gals., one of 3,000,000 gals. and a new 6,000,000-gal. engine is being erected. At the intake there is considerable trouble with needle ice in the winter, leaves in the autumn, and mud at all times. The water passes through aerators, settling basins and sand filters. The high-service station has five engines with a total capacity of 42,000,000 gals. The average daily pumpage to the city is 15,000,000 gals., about 6,000,000 gals of this being delivered to the consumer by meter measurement.

A paper on the East Side Sanitary and Levee District, by Mr. T. N. Jacobs (Chief Engineer) described the canal and levee work for the flood protection and drainage of the low lands of the "American bottoms" between the Mississippi River and the bluffs. The drainage water will be taken care of by the pumps mentioned above. Another interesting paper, by Mr. C. L. Tarbert (Board of Local Improvements, St. Louis) described the project for the new "municipal bridge" over the Mississippi, and the work done thus far on the substructure.

The report of the Secretary showed a membership of 225 and a bank balance of $878, for the end of 1910. The election of officers resulted as follows: President, J. G. Gabelman (Division Engineer, Board of Local Improvements), Chicago; Vice-President, J. A. Harman, Peoria, Ill.; Secretary, E. E. R. Tratman, 1636 Monadnock Block, Chicago. The next meeting will be held at the University of Illinois, in January, 1912.

A LARGE TITANIUM-STEEL RAIL ORDER.—An important extension of the use of titanium-steel rails is being made by the New York Central Lines. The Titanium Alloy Mfg. Co., of Pittsburg, informs us that these lines have placed an order for 41,500 tons of titanium Bessemer rails, and have specified that the steel shall be made with 1% of the ten-per cent. titanium alloy, or an equivalent of higher-grade alloy up to fifteen-per cent. alloy, i. e., 0.10% titanium addition. This is by far the largest titanium-steel rail order ever placed. Over 400 tons of 10% alloy will be required for it.

The Calumet Drainage Channel and Its Relation to the Sewage-Disposal Problem at Chicago.*

By L. K. SHERMAN,† M. Am. Soc. C. E.

The principal functions of the Sanitary District of Chicago are (1) to provide means to intercept the sewage from the city and its outlying districts in order to prevent contamination of the water-supply (Lake Michigan), and (2) to dispose of the sewage thus diverted by dilution or other means of purification. Purification by dilution requires by state law a flow of water in the main drainage canal of 200 cu. ft. per min. for each 1,000 population tributary to the canal.

With the completion of the main drainage canal‡ in 1900 and with the recent opening of the North Shore channel§ in November, 1910, all of the district is provided for with the exception of the region south of 87th St., known as the Calumet territory. This has an area of 93 sq. miles, and a population of about 150,000. It includes South Chicago, Riverdale, Harvey, Blue Island, Morgan Park, etc. All of the sewage of this territory, as well as that from the neighboring Indiana towns of Hammond, Whiting, East Chicago and Gary, is discherged into the Calumet River. The growth of this territory has developed conditions which are quickly growing intolerable. The filth settling in the Calumet River is periodically flushed out into Lake Michigan in time of freshets and contaminates the water-supply at the 68th St. crib of the Chicago water-intake system.

The Sanitary District's engineering department has made extensive studies and investigations, including the operation of a sewage-purification testing station.‖ Comparative estimates of cost of eight different projects have been made, and there have been several special engineering reports on the Calumet sewage problem. All of the plans proposed may be grouped under (A) biological purification works with effluent discharging into the lake, or (B) discharge of sewage into the main drainage canal by an auxiliary channel. Some of the latter plans include immediate or future purification treatment of sewage.

Progress in executing any plan has been delayed by the refusal of the U. S. Government to permit the reversal of flow or withdrawal of lake water through the Calumet River. On June 30, 1910, however, the Secretary of War issued this permit to the District. The detailing of plans and acquiring right of way is being pushed rapidly for active construction early in the spring.

The adopted plan is as follows: (1) The construction of a channel (capacity 2,000 cu. ft. per sec.) from the Little Calumet River near Blue Island to the main drainage canal at Sag Bridge; (2) the construction of a system of sewers which will intercept all of the sewage now discharging into the Calumet River and deliver it into the Calumet-Sag channel. The flow in the channel will be controlled by regulating works at Blue Island or at the junction of the channel with the Calumet River. A sewage pumping station will be operated at Wildwood (130th St. and Indiana Ave.) In general, all of the territory east of the station will require pumping on account of its low level. The territory west of the pumping station will drain by gravity into the channel.

The channel will have a depth of water of about 20 ft.; width in rock, about 60 ft.; width in earth, 36 ft. on bottom and 116 ft. at water surface. The average depth of cut is 30 ft. The rock section will have vertical sides made by channeling machines, as was done in the main drainage channel. Concrete retaining walls will be built on one side where the surface of rock is below the water surface. This is done as a guide to protect boats from fouling the otherwise concealed corner of rock. There will be 16 highway bridges and 8 railway bridges. The bridges are fixed (16 ft. minimum clearance), with the exception of one bascule bridge in Blue Island and the low bridges in the Calumet River. The latter are movable bridges as required by the Government, the Calumet being a navigable stream.

It is not feasible to discharge unpurified sewage into the Calumet River, as during flood periods the river (with a drainage area of 840 sq. mi.) may discharge 16,000 cu. ft. per sec. This is greatly in excess of the amount of water allowable to be added to the flow of the main drainage canal during flood periods. In the system of intercepting sewers proposed the main outfall conduit is designed for a run-off of 20 cu. ft. per sec. per sq. mile for a territory of about 50 sq. miles, or a total storm capacity of 1,000 cu. ft. per sec. About 40% of this will be carried by the Wildwood pumps. During dry weather the conduit can be flushed free from deposits by diverting a part of the water from the Calumet River into it by means of the regulating works.

The Calumet-Sag channel will require 7,130,000 cu. yds. of earth excavation, 2,236,000 cu. yds. of rock excavation and 106,000 cu. yds. of concrete guard wall. The total estimated cost (including bridges, regulating works and dredging the Calumet River) is $5,670,000. A lock will be required near the regulating works, but will be used only during periods of flood. The estimated cost of the intercepting sewers and pumping station is about $2,500,000.

The dilution method of sewage disposal is the most common one in use. When sewage is properly diluted by a sufficient quantity of water it is gradually purified by the dissolved oxygen which it contains in as complete a manner as by oxidation on land. Dilution is as scientific a method of purification as any biological process. In the case of the Calumet territory, the Sanitary District of Chicago maintains (after all its researches) that the method of dilution and disposal into the Main Drainage Canal is the only procedure available which will positively preclude the contamination of the city's drinking water from the sewage of the Calumet.

DESIGN OF THE CHANNEL CROSS-SECTION.—The problem of designing the cross-section of the Calumet-Sag channel for a flow of 2,000 cu. ft. per sec. involved some peculiar and interesting hydraulic problems. Water was to be taken from Lake Michigan into the main channel at Sag by two inlets, the Chicago River and the Calumet River. The flow by the latter must be 20% of the total flow in the main canal. The two streams, of course, have the same fall between the water surface at Lake Michigan and at Sag, but the cross-section, length and physical characteristics of the two streams are different. Moreover the water surface at Sag could not be determined by direct observation, for the reason that improvements now under way in the Chicago River will cause a higher water surface at Sag than now exists for the same flow. The coefficients for flow in canals the size of the main canal (and even of the Calumet-Sag Canal), together with the very flat slope of water surface, are outside of the range of coefficients of existing hydraulic formulas for flow in open channels. A small difference in any assumed coefficient makes a large difference in any computed elevation of water surface, and consequently a large difference in the resulting flow.

From the number of observations made on the quantity of flow and slope of water surface in the main Drain Canal the writer computed the values of n, the "coefficient of roughness" in Kutter's formulas, and adopted values for n as 0.029 for rock section and 0.038 for earth section of the main canal. With these coefficients and a computed elevation of water surface at Sag of 2.71 ft. below Chicago datum, the writer computed the sections required on the Calumet-Sag Channel for a flow of 2,000 cu. ft. per sec. Kutter's n is a variable for very large channels of flat slope, and the real values of n for the smaller Sag channel might have been taken consistently at a slightly lower figure. However, it was desirable that in no event should the Sag channel capacity be less than 2,000 cu. ft. per sec., and as regulating works were provided to govern the flow, the above figures were used.

Objection to the use of Kutter's formulas and others has been made by some hydraulic engineers. They offer the fact that the variation of assumed n offsets the result as much as the variation of an assumed C for coefficient of velocity. No formula for flow in open channels is of value unless it is used in a comparative way and with judgment based on more or less experience. Personally the writer prefers a formula of Kutter's type on the theory that analysis is more readily made where the factors are separate and can be considered one by one, than where the three or more factors are combined in one figure coefficient.

The writer made several computations to determine the extent to which the required Calumet-Sag canal section would be affected by the use of different coefficients. Assuming that the coefficient of roughness n is the same for the same character of bed in both the main canal and the Calumet canal, it was found that the use of values of $n = 0.030$ changed the total amount of excavation only 3%.

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors at East St. Louis, Ill., Jan. 25-27, 1911.

†Assistant Engineer, Sanitary District of Chicago, Chicago.

‡Engineering News, July 22, 1909.

§Engineering News, Jan. 5, 1911.

‖Engineering News, March 31, and June 16, 1910; Nov. 18, 1909.

Annual Meeting of the Canadian Society of Civil Engineers.

The 25th annual meeting of the Canadian Society of Civil Engineers was held at Winnipeg, Man., from the morning of Jan. 24 until noon of Jan. 27. At the opening session, resolutions were adopted lamenting the death on Jan. 23 of J. E. Schwitzer, a member of the Society, who was recently appointed Chief Engineer of the Canadian Pacific Ry. The greater part of this session and of the afternoon session on the same day was occupied with the reading and discussion of committee reports.

The report of the Council announced the present membership of the Society, not including 35 pending applications, as 2,739. The three largest classes were as follows: members, 548; associate members, 949; students, 1,175. The Gzowski Medal had been awarded to Mr. C. N. Monsarrat, M. Can. Soc. C. E., for his paper on "Construction of the Lethbridge Viaduct, Crow's Nest Branch, Canadian Pacific Ry." A pamphlet entitled "Standard Specifications for Cast-Iron Water Pipe and Special Castings" had been distributed as the report of the special committee appointed for the purpose. A committee has been appointed by the Council to prepare standard specifications for steel structures. The treasurer's report called special attention to the amount of old arrears in membership dues (more than $4,000) which had been collected during the year. The cash balance in the treasury Dec. 31 was about $6,500.

The committees on Portland Cement Specifications, on Roadbed and Ballasting, on Transportation Routes and on the Establishment of [Government] Testing Laboratories reported progress.

The report of the committee on Railway Ties advocated the superiority of a longer tie than the present standard. The 8-ft. ties did not give sufficient support, according to the committee. The base area of the ties under a rail length, of late years, had been increased only 50%, while the loads had increased from 200 to 300%. The best practice with the present 8-ft. ties was to tamp them firmly for a distance from each rail toward the center of the track equal to the length of tie outside the rail. If fully tamped to the center of the track, the ties were liable to bend and break under load. This left 23% of the tie's length, in the middle of the track, that could not be utilized for bearing surface on the ballast. Further points in favor of the longer ties were given as follows:

Ties 7 ins. thick, 10 ft. 6 ins. long, with 9-in. face, would give about 70% increased support at an increased cost of only 31%. No increased width of ballast section would be necessary for the longer ties, because no shoulder of ballast would be required at the ends of such ties, so that the actual yardage of ballast required would be slightly decreased by the increased space occupied by the ties. . . . At the present average price of 50 cts. for 8-ft. ties, they cost about 36% of the cost of 80-lb. rails and fastenings, which would only be increased to 42% by using the longer ties. The improved condition of track and saving in maintenance of rails and rolling stock would probably soon more than offset the difference in cost of ties.

The committee did not presume to say that even the best railways should make at once so radical and costly a change from long-established practice, but it recommended experiments with ties 10 ft. 6 ins. long. Three of the committee members, W. B. Mackenzie, T. C. Burpee and Henry Holgate dissented from that part of the report relating to the use of 10-ft. 6-in. ties. Those who signed the report were D. Mac Pherson, H. D. Lumsden, F. P. Gutelius, M. J. Haney, Wm. McNab, J. G. Sullivan, H. A. Woods, M. H. McLeod, A. F. Stewart, W. A. Bowden and H. G. Kelley.

The woods recommended for general use in the Canadian climate for untreated ties used with tie-plates were as follows, listed in order of merit with regard to life and initial cost: cedar, tamarack, oak, yellow pine, hemlock. For treated ties, used also with tie-plates, the order of merit was as follows: yellow pine, tamarack, hemlock, oak.

The committee on Rails, Fastenings and Tie-Plates gave, in its report, a review of the increase in wheel loads to which the rails are subjected as a result of the increase of car capacities and engine weights. The computed fiber stresses under an engine axle loading of 50,000 lbs. were, in 60-lb. rails, 28,000 lbs.; in 80-lb. rails, 18,750 lbs.; and in 100-lb. rails, 12,842 lbs. These were computed by considering the rail over three ties as a continuous girder having an unstable center support. Experiments on the New York Central & Hudson River R. R., with an automatic recording machine which measured rail deformations, had shown that the computed stresses were somewhat exceeded at speeds of 30 to 40 mi. per hr. with 80-lb. rails. Experiments with rail joints had shown that a tensile stress of 12,000 lbs. per sq. in. could be produced in the unloaded rail, due to its contraction in falling temperature, before the grip of the joint would permit the rail to slip and relieve itself. A combination of the various stresses might, in the opinion of the committee, bring the total stress

up close to the elastic limit of the rail steel. The principal need for improvement in the production of rail steel was for uniformity in the quality.

The committee on Conservation was made up of two members from each Province of the Dominion, with two additional members each, from Ontario and Quebec. The committee members had been requested to write short articles discussing the salient points involved in conservation with special reference to their particular districts. Such articles had been submitted prior to the meeting as follows: "Conservation of Water in the Basin of the Grand River, Western Ontario," W. H. Breithaupt; an article of 1,500 words from R. W. Leonard, representing southern Ontario; "Water Powers in Nova Scotia," R. McColl; "Forests and Water Powers," R. O. Sweezey, representing northern Quebec; and a letter from G. A. Bayne, representing Manitoba. These papers were published in full as a part of the report of the committee.

Sewage disposal conditions in Canada had been investigated by the committee on that subject by sending a list of questions to all towns of 1,000 population or over. The list was sent to 327 places in all, and replies were received from 166, of which 124 were in Ontario, Quebec and Nova Scotia. The information thus obtained showed that not much had yet been done in Canada in the way of purification of either water or sewage. At the same time, it indicated that favorable local conditions had so far prevented any serious consequences.

In the maritime Provinces, the sewage is in most cases discharged into sea water where the dilution is sufficient to prevent nuisances. In Quebec and Ontario, many towns discharge sewage into the Ottawa and St. Lawrence Rivers or the Great Lakes, and obtain their water-supplies from the same sources. The dilution was great, but in certain important cases, the water was unsafe for drinking without previous purification. In some cases the effect of eddies resulted in the contamination of the water-supply by the sewage of the same place. In the northwest Provinces, the water-supply problem was unusually difficult, as in many cases the supply must be taken from the rivers which received more or less directly the discharge from all sewage systems. In British Columbia the conditions on the coast were similar to those on the Atlantic seaboard. Up to the present time, the water-supplies in that Province had been obtained from mountain streams or lakes whose water sheds could be protected.

Two appendixes to the report contain extracts from the Public Health Acts of the different Provinces, relating to stream pollution and sewage disposal, and a tabulation of replies received to a list of questions sent out to the public health departments of several of the United States. The replies were considered by the committee to give a very fair idea of the present legislation on the subject in this country.

The members were entertained at luncheon on the first day of the meeting by the Mayor of Winnipeg, W. Sanford Evans. Wednesday, Jan. 25, was devoted to excursions to various points of interest, with the annual banquet in the evening.

At the Thursday morning session, the good roads movement was discussed and it was decided to appoint a committee from the council to investigate the subject.

The retiring president, Col. H. N. Ruttan, in his address delivered at the Thursday afternoon session, Jan. 26, discussed the chartering, location and construction of railways, with special reference to railways in Canada. He asserted that much comparatively useless road had been constructed. He named, as follows, some of the causes for this condition:

Want of knowledge of the country in the construction of the first lines. The desire of capitalists to share in profits being earned by favorably situated lines. The ease with which charters for so-called competing lines may be obtained. The relatively slight interest taken by the public in the location of transportation lines, and the mistaken idea that the construction of any line is advantageous.

It was important, he said that a broad and intelligent view of the situation be taken to avoid useless duplication of facilities. He recommended the granting of compulsory running rights over existing lines to companies which might properly partfcipate in the traffic of certain districts. They would obviate the necessity of heavy expenditures for the construction of parallel lines not warranted by the volume of traffic.

Mr. W. G. Chace, at the Thursday afternoon session, presented an illustrated paper describing the Winnipeg municipal power plant, now under construction.

At the closing session, Jan. 27, Mr. A. L. Mudge read an interesting paper on the hydro-electric development work of the British Canadian Power Co. in the Cobalt district.

Officers for 1911 were elected as follows: President, C. H. Rust, of Toronto; Vice-Presidents, Henry Holgate, of Montreal, and Charles E. W. Dodwell, of Halifax. Following is a list of the councillors for the coming year: District 1. L. A. Herdt, Montreal; Phelps Johnson, Montreal; H. G. Kelley, Montreal; J. M. Shanly, Montreal; J. G. Sullivan, Montreal, and H. H. Vaughan, Montreal. District 2. P. S. Archibald, Moncton, N. B.; F. W. W. Doane, Halifax, and R. McColl, Halifax. District 3. A. E. Doucet, Quebec; J. T. Morkill, Sherbrooke, P. Q., and P. R. Parent, Quebec. District 4. C. R. Coutlee, Ottawa; D. MacPherson, Ottawa, and W. J. Stewart, Ottawa. District 5. H. E. T. Haultain, Toronto; A. F. Stewart, Toronto; C. L. Fellowes, Toronto. District 6. E. E. Brydone-Jack, Winnipeg; J. A. Hesketh, Winnipeg, and J. G. Le Grand, Winnipeg. District 7. F. F. Busteed, Vancouver; J. S. Dennis, Calgary, Alta; J. H. Kennedy, Keremeos, B. C.

A SNOWSLIDE IN UTAH Jan. 31 buried the offices and bunk house of the Utah Coalition Mine in Big Cottonwood Cañon, near Alta. Three men in the office were killed and ten who were in the bunk house are reported missing.

A BRICK CHIMNEY FELL at Whippany, N. J., during a high wind Jan. 28 at the plant of the Caledonia Paper Mill, owned by the United Boxboard Co. One man was killed and another badly injured.

A POWDER MILL EXPLOSION in the press-room of the Miami Powder Co., at Fayville, Ill., Jan. 21, caused the death of three men.

A COLLIERY FIRE at Sosnowice, Russian Poland, Jan. 20, caused the death of 40 of the 400 miners at work when the fire started.

A FLY-WHEEL BURST at Lowell, Mass., Jan. 26, in the Boott Cotton Mills. Pieces of the fly-wheel are reported to have passed through four floors of the mill building known as No. 7. The damage is estimated at $50,000.

THE DOMINION STEEL CORPORATION'S general offices at Sydney, N. S., were destroyed by fire Jan. 25. Many valuable papers and records were lost.

AN AEROPLANE FLIGHT from Key West, Florida, to Havana, Cuba, was attempted on Jan. 30 by J. A. D. McCurdy. After coming about 80 miles and when still ten miles from Havana, the supply of lubricating oil was exhausted and it was necessary to descend to the sea. The aeroplane was equipped with pontoons for this contingency and the machine safely rode the waves until the aviator was rescued by the torpedo boat destroyer "Paulding" which had been detailed to accompany the aeroplane. The machine was taken aboard and another attempt to cross will be made.

At Ardennes, France, on Jan. 26, Roger Sommer made a flight of 13 miles with a large biplane carrying five other men.

The Siemens-Schuckert dirigible balloon was launched near Berlin, Germany, Jan. 23. This is reported to be the largest non-rigid dirigible balloon yet constructed, being 378 ft. long. It has four 125-HP. motors and three gondolas in which 50 passengers can be carried. It was built under supervision of the Military Aerial Corps and will be purchased for the Army.

A PECULIAR PNEUMATIC CAISSON ACCIDENT at one of the piers being constructed for the Pennsylvania R. R. bridge across the Passaic River at Newark, N. J., on Jan. 31, caused the death of 10 of the 14 workmen who were in the working chamber. A bucket filled with rock and earth had just been lifted out of the material lock, when its supporting chain parted and the bucket was dropped on to the lock, breaking the gate and allowing the air to escape and the water to pour into the working chamber. Four of the workmen managed to escape through the lock but the remaining ten were drowned. Further details of the accident are not now available.

AN ADVERTISING SIGN FELL from the roof of a four-story building at Tenth and Market Sts., Philadelphia, Pa., Jan. 30. The street was crowded with pedestrians at the time, and three persons were killed, while six others were seriously injured. Reports state that the sign was about 20 ft. wide and 10 ft. high, and that it was wrenched from its fastenings by the wind.

AN ERUPTION OF MT. TAAL, 40 miles south of Manila, P. I., Jan. 30-31, is reported to have killed 400 persons.

THE PROPOSED NEW CITY CHARTER FOR ST. Louis, Mo., outlined and discussed editorially in our issue of Jan. 26, was defeated by a large majority vote at a popular election held on Jan. 31.

LEAKAGE IN THE AQUEDUCT supplying the city of Washington, D. C., is reported by Lt.-Col. W. C. Langfitt, Corps of Engineers, U. S. A., to amount to about 2,000,000 gals. a day, and in addition is threatening the stability of the famous Cabin John Arch, over which the aqueduct passes some eight miles outside the middle of the city. This report is to the Chief of Engineers and will probably be transmitted to Congress with the request that an appropriation be made with which to stop the leakage.

THE GOLD, SILVER AND PLATINUM production of California for 1909 has recently been announced by the U. S. Geological Survey. The final figures for the output in California in 1909 are as follows: Gold, $20,237,870; silver, 2,098,253 fine ounces, valued at $1,091,092; platinum, 416 refined ounces, valued at $10,400. Material gains in the output of gold and silver and a decrease in that of platinum are shown.

NATURAL GAS IN 1909 AND 1910.—The production of natural gas in the United States in 1909 has been ascertained by a joint canvass made by the United States Geological Survey and the Bureau of the Census. In an advance bulletin of the Geological Survey it is reported to have had a value of $55,000,000, an increase of only about $359,626 over that of 1908. There were no great changes in the industry during the year, the production continuing to decline in Kansas, and an increase being made in Oklahoma and in the Caddo field in Louisiana and in Texas. An interesting feature was the supplying of Fort Worth and Dallas from the gas fields of Clay County, Tex. For the year 1910 the total production is estimated at $57,000,000, an increase of about $2,000,000 over 1909. During 1910 a feature of great interest was the development of what promises to be a very large supply of natural gas in the Buena Vista Hills, Kern County, Cal., east of the Sunset-McKittrick oil field. Arrangements were practically completed during the year for piping this gas to Bakersfield and other towns in San Joaquin Valley.

STORAGE RESERVOIRS for the water-supply of London, England, estimated to cost £6,900,000 or $33,600,000 have been projected under the direction of Mr. W. B. Bryan, M. Inst. C. E., Engineer of the Metropolitan Water Board. The reservoirs would store water from the Thames. The project seems to fall in line with the ideas of Dr. A. C. Houston, Director of Water Examination, Metropolitan Water Board, who after long and detailed study is a firm believer in the efficiency of storage for the sanitary protection of the water-supply of London. In fact, he seems to regard it as almost if not quite as important as the filtration to which all the Thames supply is subjected.

RAILWAY AMBULANCE CARS have been put in service by the Swiss Government Railways for the use of wealthy invalids traveling to the various European baths and health resorts. The cars are 63½ ft. long over all and weigh 42 tons. A corridor extends along one side, with a door in the middle, and there are side doors at each end of the car. The interior is divided into compartments with a large room at the middle, into which a patient can be carried on a stretcher by the side doors. There are two compartments for the patient's companions, a room for a doctor, a kitchen and a baggage room. There are two toilet rooms, one of which connects with the invalid's room. The cars are mounted on steel-framed trucks with plate springs (isolated or not equalized) over the boxes and elliptic plate springs under the ends of the bolsters. Steam heat is provided, with apparatus for maintaining a constant temperature, and there is an auxiliary hot-air apparatus for use where steam is not available.

A SYSTEM OF MULTIPLEX TELEPHONY has been invented by Maj. G. O. Squier, Signal Corps, U. S. Army. Patents have been taken out but the use of the invention has been dedicated to the public. It is claimed that the system permits of the transmission over a single wire of a number of telephonic conversations limited by the number of different frequencies to which the several telephone circuits may be attuned. An earth return is claimed to be possible through the use of electrical condensers of such capacity that great impedence is offered to the reception of external disturbances which would be audible. Maj. Squier proposes to use sustained frequencies of 15,000 to 20,000 cycles per second, which are just beyond the limits of audibility. These sustained oscillations are not used directly and they do not affect the diaphragm of a telephone receiver. The ordinary microphone transmitter and induction coil are used to impose changes in amplitude on the sustained high-frequency oscillations, corresponding to the details of speech. These changes affect a "detector," such as is used in wireless telegraphy, which permits the passage of a correspondingly varying current, from separate source through the listener's receiver circuit. It is seen that so far the idea involved is that behind wireless telephony. The several talking circuits connected to the single transmission wire can be adjusted, by varying their inductance and capacity, to pick out only a certain desired frequency and they will not then respond to other frequencies.

The circuits are comparatively simple in diagram. The very high frequency currents used have been obtained, in Maj. Squier's experiments, from a special generator made by the General Electric Co., of Schenectady. This machine has a capacity of 2 KW. but can be run for up to 100,000 cycles per second.

TRINIDAD LAKE ASPHALT.—The quantity of asphalt taken from Pitch Lake, which covers an area of 100 acres, during 1910 exceeded that of any previous year. At the present rate of operation, the surface level is lowered about 6 ins. a year. The depth of the deposit of asphalt over the center of the lake is unknown, as it can not be sounded by rods, but the supply is supposed to equal the demand for many years; possibly it is inexhaustible.—U. S. Consular Notes, by Franklin D. Hale.

BILLS TO ABOLISH THE STATE HIGHWAYS COMmission and the Advisory Board of Consulting Engineers for the Barge Canal, in the State of New York, have been introduced simultaneously in both houses of the Legislature. These bills are in line with the recommendations of the first message of Gov. John A. Dix, and it is reported will be further advocated by him in another special message.

The present Highways Commission is of about two years' standing. It consists of a chairman, at an annual salary of $6,000, and two members, one of whom is an engineer, at $5,000 each. It has control of all of the construction and maintenance of the state highways for which the state by popular vote authorized a bond issue of $50,000,000 a few years ago. Up to the time the Highways Commission was created, the state road work was done under direction of the State Engineer. The recently introduced bills abolish the Commission, and create a new office, the State Superintendent of Highways, with a salary of $8,000 per year. All plans and specifications for highway improvement are placed in the hands of the State Engineer; the awarding of contracts is to be under the State Superintendent of Public Works and the general administrative and construction work under the new Commissioner. These three officials are to make up the new Highways Commission.

The Advisory Board of Consulting Engineers of the Barge Canal, which has been in existence since the beginning of the canal work in 1904, now consists of a chairman at $8,000 per year and four members at $7,500 per year. Its duty has been to supervise and approve the plans of the State Engineer for the canal work. By the new bills the Board is abolished and is ordered to turn over all of its effects to the State Engineer, who is to have sole charge of the engineering work of the canal, with the power to employ one or more consulting engineers from time to time, with the approval of the Governor. The Canal Board, made up of the higher elective members of the state administration, is not affected by the new law. It is still to have executive control of the construction of the canal.

The new bills show very conclusively that the intention of the administration is to place in the hands of the State Engineer and Surveyor all of the engineering work carried on by the state.

Personals.

Mr. J. W. Paxton, a civil engineer of Norfolk, Va., has been appointed Superintendent of Street Cleaning of Washington, D. C.

Mr. F. E. Semon, formerly assistant to City Engineer Foster of Medford, Ore., has been appointed City Engineer of Ashland, Ore.

Mr. H. C. George, M. Am. Inst. M. E., formerly director of the Wisconsin State Mining Trade School, has been appointed Engineer for the Wisconsin Zinc Co.

Mr. N. H. Darton, M. Am. Inst. M. E., for a number of years Geologist of the United States Geological Survey, has been appointed Geologist of the United States Bureau of Mines.

Mr. Herman Nieter, formerly Sales Manager for the Canton Boiler & Engineering Co., of Canton, Ohio, has been appointed General Sales Manager of the Kennicott Co., of Chicago, Ill.

Mr. E. T. Pardee, formerly Manager of the Boston, Mass., office of the Allis-Chalmers Co., has been made Manager of the Power and Electrical Department for the same company at Milwaukee, Wis.

Mr. A. S. Dawson, M. Can. Soc. C. E., Assistant Chief Engineer of the Canadian Pacific Ry. Co.'s Irrigation Department, has been promoted to be Chief Engineer of the same with headquarters at Calgary, Alta.

Mr. Harold Kirschberg, Assoc. Am. Inst. E. E., formerly Illuminating Engineer with the Pennsylvania R. R. Co., has opened an office in New York City as Engineer for the Heany Lamp Co., of New York.

Mr. F. W. Gilcreast, formerly Division Engineer of the Lehigh Valley R. R., at Hazleton, Pa., has been appointed Chief Engineer of the Lehigh & New England R. R., with headquarters at Mauch Chunk, Pa.

Mr. Francis H. Wisewell, Jun. Am. Soc. M. E., formerly of Westinghouse, Church, Kerr & Co., and of the International Heater Co., has been elected Vice-President of the Mohawk Valley Heating Co., of Utica, N. Y.

Mr. Frank E. Brown, formerly of the Department of Water Supply, Gas and Electricity of the City of New York, has become associated with Mr. Halbert P. Hill, Consulting Engineer, 30 Church St., New York City.

Mr. Frank H. Joyner, formerly Division Engineer of the Massachusetts Highway Commission, has been appointed Engineer of Maintenance of Los Angeles County, California, in charge of highway work. Mr. Joyner left for his new position on Feb. 1.

Mr. W. H. Thomson, Jr., Assoc. Am. Inst. E. E., of St. Louis, Mo., has been appointed Operating Engineer of the Illinois Traction System with headquarters at Peoria, Ill., Mr. Ralph Carley, Assoc. Am. Inst. E. E., of Quincy, Ill., and Mr. Frank W. Bedard, Gas Engineer, have been appointed assistants to Mr. Thomson.

Mr. Gerardo Immediato, Assoc. M. Am. Soc. C. E., has been appointed by the Town Council of Montclair, N. J., to the newly-created position of Town Engineer. Mr. Immediato is a graduate of Columbia University of the class of 1901, and was formerly Assistant Engineer of the Monterrey Water-Works at Monterrey, Mexico.

Obituary.

Calvin B. Orcutt, President of the Newport News Shipbuilding Co., died at his home in Elizabeth, N. J., on Jan. 30. He was an associate of the Society of Naval Architects and Marine Engineers and of numerous New York City clubs.

Martin Luther Newton, formerly City Engineer of Waterloo, Iowa, died in that city on Jan. 24, after an illness of several weeks. He was born in Freeport, Ill., on May 27, 1851, and was educated at the Freeport High School and the University of Michigan, from which he graduated in the course in civil engineering in 1875. He was a member and Past-President of the Iowa Engineering Society. Since 1903 he had been Chief Engineer of the Waterloo, Cedar Falls & Northern Ry. Co.

William O. Seymour, a member of the Connecticut Railroad Commission, died at his home in Ridgefield, Conn., on Jan. 24, from heart disease, after an illness of a few days. He was 78 years old. Until about 20 years ago he was actively engaged in engineering work with what is now the New York, New Haven & Hartford R. R., the Boston & Maine R. R. and the Wisconsin Central R. R. He was also a member of the General Assembly of his native state and was a member of its constitutional convention in 1902.

Horace J. Howe, M. Am. Soc. C. E., Assistant Engineer of the Public Service Commission, First District, of the State of New York, died at his home in Yonkers, N. Y., on Jan. 22. His early home was in Medford, Mass. He graduated from the Massachusetts Institute of Technology in 1879, the youngest member of his class. For several years he was engaged in construction work in the West. For the past few years he had been a member of the engineering organization engaged on subway plans and construction in New York City. He leaves a widow and four young children.

Jarvis Bonesteel Edson, M. Am. Soc. M. E., a mechanical engineer and inventor, died at his home in New York City on Jan. 26. He was born in Janesville, Wis., on April 30, 1845. He was the inventor of the Edson pressure recording gage, of a method of drying gun cotton, of a method for sinking deep wells in clay, quicksand, etc., and some 20 other devices. During the Civil War he served in both the Army and the Navy. He was a member of the American Society of Naval Engineers, the Society of Naval Architects and Marine Engineers, the Franklin Institute of Philadelphia, the Engineers' Club of New York and numerous other organizations.

Joseph W. Reinhart, a former President of the Atchison, Topeka & Santa Fe Ry., died in Kansas City, Mo., on Jan. 27 from pneumonia. He was born in Pittsburg, Pa., on Sept. 17, 1851. He attended the Western University of Pennsylvania until 18 years of age when he entered the railway service as a clerk for the Division Superintendent of the Allegheny R. R. In 1875 he became Superintendent of Transportation for the same road. From 1880 to 1883 he was Auditor for the Richmond & Allegheny R. R. at Richmond, Va. Later he held the same position for the New York, West Shore & Buffalo R. R. and the Lake Shore & Michigan Southern R. R. In 1888 he became General Auditor for the Santa Fe lines and in 1893 President of the same; later he became Receiver of the same properties. In 1894 he was Chief Expert for the United States Government under the 53d Congress in the reorganization of the executive departments. More recently he had held the position of President of the Kansas City Viaduct and Terminal Co.

Engineering Societies.

COMING MEETINGS.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 6-11. Annual convention at Louisville, Ky. Secy., T. A. Randall, Indianapolis, Ind.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 14-15. Annual meeting at New London, Conn. Secy., J. Frederick Jackson, New Haven, Conn.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 15. Annual meeting at Boston, Mass. Secy., N. W. Gifford, 26 Central Square, East Boston, Mass.

IOWA ENGINEERING SOCIETY.
Feb. 15-17. Annual meeting at Des Moines, Iowa. Secy., S. M. Woodward, Iowa City, Iowa.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.
Feb. 28-March 1. Annual convention at Minneapolis, Minn. Secy., Harvey B. Smith, 834 Security Bank Bldg., Minneapolis, Minn.

CANADIAN MINING INSTITUTE.
March 1-3. Annual meeting at Quebec, Que. Secy., H. Mortimer Lamb, Windsor Hotel, Montreal, Que.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.
March 6-11. Annual convention at Toronto, Ont. Secy., Wm. Snath, 57 Adelaide St., East Toronto, Ont.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 21-23. Annual convention at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago, Ill.

ILLINOIS WATER SUPPLY ASSOCIATION.—The third annual meeting will be held at the University of Illinois, Urbana, Ill., Feb. 21-22.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting held in New York City, Feb. 1, Mr. Geo. R. G. Conway's paper, entitled "The Water-Works and Sewerage of Monterey, N. L., Mexico," was presented for discussion.

NEW ENGLAND WATER WORKS ASSOCIATION.—At the meeting in Boston, Mass., Feb. 8, papers will be presented as follows: "Construction Work on the Water Supply of New York City," by J. Waldo Smith, and "The Use of the Salinometer in Studies of Sewage Disposal by Dilution," by Kenneth Allen, Chief Engineer of the Metropolitan Sewerage Commission of New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—At the meeting of Feb. 14 at the Engineering Societies' Building, New York City, Mr. John Calder, Manager of the Remington Typewriter Works, Ilion, N. Y., will present a paper on "The Mechanical Engineer and Prevention of Accidents."

ALBANY SOCIETY OF CIVIL ENGINEERS.—At the annual meeting held Jan. 24 at the Hampton Hotel, Albany, N. Y., officers were elected as follows: President, Russell S. Greenman; Vice-Presidents, James R. Watt, David R. Cooper and Emory E. Brandow; Secretary, Rupert Sturtevant; Treasurer, R. F. T. Wilke.

BOSTON SOCIETY OF CIVIL ENGINEERS.—An engineers' dinner was held at the Hotel Somerset, Boston, Mass., Jan. 31, under joint auspices with the American Institute of Electrical Engineers (Boston Section) and the American Society of Mechanical Engineers. Like the one held last year, this dinner was intended "to promote the interests of all engineers in Boston and vicinity."

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.—The 27th annual meeting will be held at New London, Conn., Feb. 14-15. Papers to be presented are as follows: Feb. 14—"The Catskill Water-Works for New York," Alfred D. Flinn, Department Engineer, New York Board of Water Supply; "Some Features of Baltimore's $10,000,000 Sewerage System," H. M. Knight, formerly Engineer with the Baltimore Sewerage Commission; "The Congress Street Bridge," R. F. Stoddard. Feb. 15—"Testing Water-Wheels After Installation," Prof. Charles M. Allen, Worcester Polytechnic Institute; "The Relation of Weather and Forestation to Stream Flow," W. L. Moore, Chief of U. S. Weather Bureau; "Actual Yield of a Typical Connecticut Watershed," R. A. Cairns, City Engineer of Waterbury, Conn.